AD NUMBER

AD808527

NEW LIMITATION CHANGE

TO

Approved for public release, distribution unlimited

FROM

Distribution authorized to U.S. Gov't. agencies and their contractors; Critical Technology; FEB 1967. Other requests shall be referred to Air Force Aero Propulsion Labortory, Attn: AFF, Wright-Patterson AFB, OH.

AUTHORITY

afapl ltr, 12 apr 1972

AFAPL
PART I

RAPID PREPARATION OF QUICK-CURE RESIN TEST SITES IN SOUTHEAST ASIA

Part I Southeast Asia Test Program

Clarence Blakeley and Francis Gifford
LTV Aerospace Corporation, Vought Aeronautics Division

TECHNICAL REPORT AFAPL-TR-66-148, PART I

28 FEBRUARY 1967

AIR FORCE AERO PROPULSION LABORATORY
RESEARCH AND TECHNOLOGY DIVISION
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

NOTICES

When U. S. Government drawings, specifications, or other data are used for any purpose other than a definitely related Government procurement operation, the Government thereby incurs no responsibility nor any obligation whatsoever, and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise, or in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

Copies of this report should not be returned to the Air Force Aero Propulsion Laboratory, Research and Technology Division, Air Force Systems Command, Wright-Patterson Air Force Base, Ohio, unless return is required by security considerations, contractual obligations, or notice on a specific document.

RAPID PREPARATION OF QUICK-CURE RESIN TEST SITES IN SOUTHEAST ASIA

Part I Southeast Asia Test Program

Clarence Blakeley and Francis Gifford

FOREWORD

This report was prepared by Vought Aeronautics Division of LTV Aerospace Corporation, Dallas, Texas under USAF Contract F 3361567C1009. The contract was initiated under BPSN 7 (63 817401 62405214). The work was administered under the direction of the Support Techniques Branch, Air Force Aero Propulsion Laboratory, Research and Technology Division, Air Force Systems Command, Wright-Patterson Air Force Base, Ohio. Captain A. L. Telford/APFG was the Air Force technical monitor.

The work conducted under this contract will be reported in two parts: Part I, Southeast Asia Test Program, and Part II, Remote Site Preparation Equipment.

This report covers the Southeast Asia Test Program which was conducted from 1 June 1966 through 9 October 1966. Mr. F. Gifford was the Principal Investigator. Technical assistance was provided by Messrs. G. F. Thomas, Materials Specialist, and C. J. Blakely, Systems Lead Test Engineer. This report was submitted by the authors on 28 February, 1967

The assistance of Messrs. H. R. Bankhead and M. A. Sheets of the Air Force Aero Propulsion Laboratory is gratefully acknowledged.

This technical report has been reviewed and is approved.

A. Vasiloff
A. VASILOFF
Tech Area Manager
Ground Support Branch
Support Technology Division

ABSTRACT

Various types of load bearing and weather-resistant surfaces were fabricated in Southeast Asia (SEA) utilizing a quick-curing fiber glass reinforced resin system (previously demonstrated successfully under contract AF 33(615)-3631 Rapid Shelter Flooring and Helicopter Landing Sites). These test sites were constructed to gain operational data in the use of this construction method when utilized in a remote environment under actual use conditions. Ten different types of sites were constructed as follows: sand ammo revetment stabilization, cargo storage, engine runup station, sand bag emplacement, pierced steel planking overspray, roadway, heliport, helicopter maintenance area, Quonset hut joint sealing, and metal revetment joint sealing sites. In addition, a team of 10 Air Force personnel was trained to use the Rapid Site application equipment. Latex base soil stabilization material was also tested in SEA on sand, but was not considered fully satisfactory because it broke up under foot traffic and high wind velocities. Prior to departure for SEA a 10-man LTV team was selected and trained, and specialized techniques were developed and tested. Other tests that were conducted included material toxicity, resistance to certain fluids, and rheological properties testing. A suitcase field laboratory was fabricated with equipment for determining stability, viscosity, gel time, active oxygen, and other material properties. The Rapid Site equipment operated continually under adverse environmental conditions encountered there (heat, humidity, sand, etc.) with no major problems. Inspection of the sites just prior to leaving revealed that all sites were performing their intended functions well, and were generally in very good condition. It is concluded that the Rapid Site System provides a very good solution to many of the various problems in remote locations like SEA.

(This document is subject to special export controls and each transmittal to foreign Government or foreign Nationals may be made only with prior approval of the Air Force Aero Propulsion Laboratory (APF), Wright-Patterson AFB, Ohio.)

PAGES NOT FILMED ARE BLANK.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (Continued)

LIST OF TABLES

LIST OF TABLES (Continued)

SECTION I

INTRODUCTION

As a result of the Air Force requirement to develop materials and equipment suitable for the rapid preparation of remote operational sites for vertical takeoff and landing aircraft, an extensive development program was undertaken. During that program, a polyester resin modified with certain ablative materials and reinforced with fiber glass was developed. In conjunction with this, an equipment application system was designed and fabricated. Subsequently, full-scale sites (50- to 66-foot diameter) were prepared in the U. S., England, and Germany. These sites were tested with the X-14A, P.1127, and VJ101-X2 VTOL aircraft, respectively. Minor material problems, due to material shrinkage, were encountered in the European tests, but modification of the resin compound has eliminated this problem.

As a result of requirements generated in Southeast Asia (SEA), an additional effort, under Contract AF 33(615)-3631, was undertaken to investigate the use of the Rapid Site resin system in fabricating helicopter sites and shelter floors. A 120-foot diameter helicopter site was prepared and was tested sucessfully with S-58, UH-1, and CH-37 helicopters. This site was also tested successfully with the XC-142A V/STOL aircraft. In addition, a 16- by 32-foot shelter floor was constructed over soft sand and subjected to various static and rolling wheel loads.

Since the technology of preparing various types of sites with this quick-curing resin material has been demonstrated successfully in numerous full scale tests, an evaluation of the Rapid Site system was warranted under remote area environmental conditions. Therefore, the original objective of this program was to gain operational data in the use of the polyester resin rapid site construction method when utilized in a remote environment under actual use conditions. More specifically, the detailed objectives of the Southeast Asia program were to :

a. Assist the United States Air Force (USAF) in selecting and utilizing to the best advantage a fast setting resin/chemical system that had been demonstrated under contracts AF33(615)-3068 and AF33(615)-3631.

b. Conduct a preliminary trip (two contractor project engineers) jointly with Air Force (APFG) project engineers to Southeast Asia (prior to conducting the actual test program) to evaluate soil and operating conditions and determine personnel and operational support requirements.

c. Conduct an evaluation and training program to develop specific application techniques, prior to departing.

d. Stabilize three ammunition revetments using a different technique for each respective application.

e. Fabricate a 150-foot square combined aircraft parking and storage area test section.

f. Construct a 150-foot diameter helicopter landing site.

g. Prepare a weather-resistant surface over three actual sand bag emplacements.

h. Instruct 7th Air Force personnel in the Rapid Site equipment operation and spray techniques.

i. Design and fabricate a complete application equipment system as a replacement item for the equipment that was to remain in SEA.

j. Test other materials besides polyesters for soil stabilization.

During the program the specific site requirements were modified, as required, in order to better meet the needs of the local area - while still maintaining the original program objective. Item number i, above, (the design and fabrication of replacement application equipment) will be reported under Part II, Remote Site Preparation Equipment, of this report.

All sites were prepared over sand, within the confines of established military reservations.

SECTION II

SUMMARY

Prior to team departure for Southeast Asia, Mr. F. Gifford and Mr. G. F. Thomas accompanied Captain A. L. Telford and Mr. M. A. Sheets of the Air Force Aero Propulsion Laboratory to SEA on an advance trip to determine the operational support requirements. A 10-man LTV team was selected and trained, and specialized techniques were developed and tested in preparation for SEA operations. Other tests that were conducted included material toxicity, resistance to certain fluids, and rheological properties testing. A suitcase field laboratory was fabricated with equipment for determining stability, viscosity, gel time of the resin and active oxygen of the catalyst, and other material properties.

Quick-cure resin test sites were constructed in SEA as follows:

a. Sand Ammunition Revetment Site

Three types of coverage were used - resin only, resin with woven glass, and resin with spray glass. The resin-only area was not satisfactory due to cracks that resulted from sand shifting and was subsequently recovered with woven glass and resin. Both the resin with spray glass and resin with woven glass performed well.

b. Cargo Storage Site

Three material thicknesses were fabricated (nominal two, four, and six pounds per square foot). All three areas performed well under cargo storage and wheel loading conditions.

c. Quonset Hut Site

A 35-foot long joint was sealed with chopped glass fiber and resin in order to prevent leakage during rain storms. Leakage occurred at another seam during the next rain and since arrangements could not be made for scaffolding, and the exact leakage spots were undetermined, this task was terminated.

d. Two-Engine Runup Station Sites

Sand stabilization was accomplished to prevent undermining erosion caused by jet blast turbulence. Both sites looked very good after subjection to F4C jet engine blast testing.

e. Metal Revetment Site

A section of a metal revetment was stabilized by sealing the joints with various combinations of fiber glass and resin to prevent sand from being drawn through the joints during engine runup. Inspection of the test section after runup of a F4C airplane revealed that the best method of sealing was chopped glass and resin.

f. Sand Bag Emplacement Site

A sand bag emplacement was stabilized by covering the top with woven glass, spray glass, and resin. The sides were stabilized with resin only with an additive of two percent Cab-O-Sil.

g. Pierced Steel Planking (PSP) Fire Station Driveway Overspray Site

A PSP driveway was covered with woven glass, spray glass, and resin to keep the sand from sifting up through the PSP. Prior to spraying, an attempt was made to dry out one low, wet section of the PSP; however, the area was still relatively damp when covered. Subsequent inspection revealed that the covering had apparently separated from the PSP in the damp area, which was not detrimental to utilization of the site.

h. Driveway Site (adjoining the cargo storage area)

A nominal four pounds per square foot entryway was prepared in an area which carried all the traffic unloading the C-130 airplanes. Subsequent inspection revealed no damage after several days of use, even though the area where the pad was tied to aluminum planking received considerable flexing (every time a heavy load ran off the pad onto the loose planking).

i. Helicopter Landing Site

A 120-foot square, nominal two pounds per square foot density helicopter landing site was constructed. Several landings by UH-1 helicopters did no damage to the site.

j. Helicopter Maintenance Area Site

A site was constructed connecting to a PSP area utilized for helicopter maintenance.

During the site construction period, a 10-man Air Force team was trained to use the Rapid Site equipment. Upon completion of the sites, the Air Force team was sufficiently trained to take over the application equipment and construct additional sites in SEA. Also Soil Guard, a soil stabilization material, was tested. The covering was similiar to other available dust palliatives in that its effectiveness was quite limited with respect to time and trafficability. Maximum benefit would be obtained in non-traffic areas and effective life expectancy, although not specifically determined, probably would not exceed current dust palliative materials.

SECTION III

PROGRAM MATERIALS

A. MATERIAL ACQUISITIONS

All materials for the testing and training program were purchased by LTV and are listed in Table I, page 6. All materials purchased for use in SEA were purchased by the Air Force Aero Propulsion Laboratory, Research and Technology Division, Wright-Patterson Air Force Base, Ohio. These materials are listed in Table II, page 7. Table III, page 8, shows material usage in SEA.

B. RHEOLOGICAL PROPERTIES TESTS OF RAPID SITE RESIN

The rheological properties, i.e., flow and deformation characteristics of Rapid Site resin were determined for certain conditions for a 30-degree incline - to act as a guide for field application. Viscosities, flow rates, and cure rates were determined. The materials used for this test were as follows:

1. Hetron 24689 resin (composed of Hetron 31 and Hetron 42 resins in a 3:1 ratio, with inhibitor added by the manufacturer to obtain better storage characteristics under the extreme temperature conditions in SEA)

2. Cobalt naphthenate

3. N, N-dimethylaniline

4. Cab-O-Sil M-5

Viscosity tests were conducted on five samples (Resin only and resin mixtures with 1%, 2%, 3% and 4% Cab-O-Sil). The samples were heated in a constant temperature bath to 120°F. As the resin cooled, viscosity readings were taken at 110°F, 90°F, and room temperature. No promoters were added for the viscosity tests. All Cab-O-Sil mixtures were allowed to stand for twenty-four hours before testing. Table IV, page 9, and Figure 1, page 10, show the effect of temperature and Cab-O-Sil variations on resin viscosity. Figure 2, page 11, shows the effect of temperature differences on viscosity for resin without Cab-O-Sil.

Curing rate tests were conducted on resin with promoters (cobalt naphthenate and dimethylaniline) and catalyst (methylethylketone peroxide) mixed in varying concentrations to establish gel times of approximately 6, 12, and 18 minutes. The promoted resin (in 250-gram quantities) was mixed with catalyst and stirred for thirty seconds. Then 50-gram quantities were immediately poured into the lid of a cardboard container and the gel time was determined. The results of these tests are presented in Table V, page 12.

Flow tests were conducted on a 30-degree incline. Nine specimens were mixed for testing (6-, 12-, and 18-minute gel times each with 2%, 3%, and 4%

TABLE I LIST OF MATERIALS ORDERED BY LTV FOR TRAINING AND TESTING

Quantity	Description
20 drums (55 gallons each)	Hetron 24689 polyester resin (modified Hetron 24505 containing increased inhibitor and no cobalt naphthenate) (550 pounds/drum net)
3 rolls (84 inches wide by 80 yards long)	Fiber glass woven roving fabric FGI 2454 (1.5 pounds/square yard)
6	Extra cores to fit the above rolls.

TABLE II LIST OF MATERIALS ORDERED BY THE USAF FOR USE IN SOUTHEAST ASIA

Quantity	Description
611 drums (55 gal. ea)	Hetron 24689 polyester resin (modified Hetron 24505 containing increased inhibitor and no cobalt napthenate) (550 pounds/drum net)
53,750 pounds (80 inches wide by 120 ft long roll size)	Fiber glass woven roving fabric, KC2408 (1.5 pounds/square yard)
33,100 pounds	Fiber glass continuous filament roving, 135-385 (approximately 30 pounds/roll)
8 drums (55 gal. ea)	Cobalt naphthenate
50 drums (55 gal. ea)	Acetone
1 drum (55 gal.)	N, N-Dimethylaniline (DMA)
158 cartons	Methylethylketone peroxide (4 containers, 8 lbs ea per carton)
2,000 pounds	Cab-O-Sil M-5

TABLE III LIST OF MATERIALS USED IN SOUTHEAST ASIA

Material Type	Unit of Measure	Initial Quantity	Quantity Used in SEA	Quantity Remaining in SEA
Resin	55 gal drum	611	414	197
Woven roving glass fabric	125 lb rolls	424	274	150
Glass gun roving	30 lb spools	1,100	596	504
Acetone	55 gal drums	50	26	24

TABLE IV VISCOSITIES IN CENTIPOISES OF HETRON 24689 WITH DIFFERENT CONCENTRATIONS OF CAB-O-SIL OVER A RANGE OF TEMPERATURE

	Cab-O-Sil, M-5				
Temperature	0%	1%	2%	3%	4%
80°F	1740	2360	3120	7080	9280
90°F	1000	1580	2100	5320	6500
100°F	740	1120	1660	4460	5600
110°F	640	960	1460	3800	5300

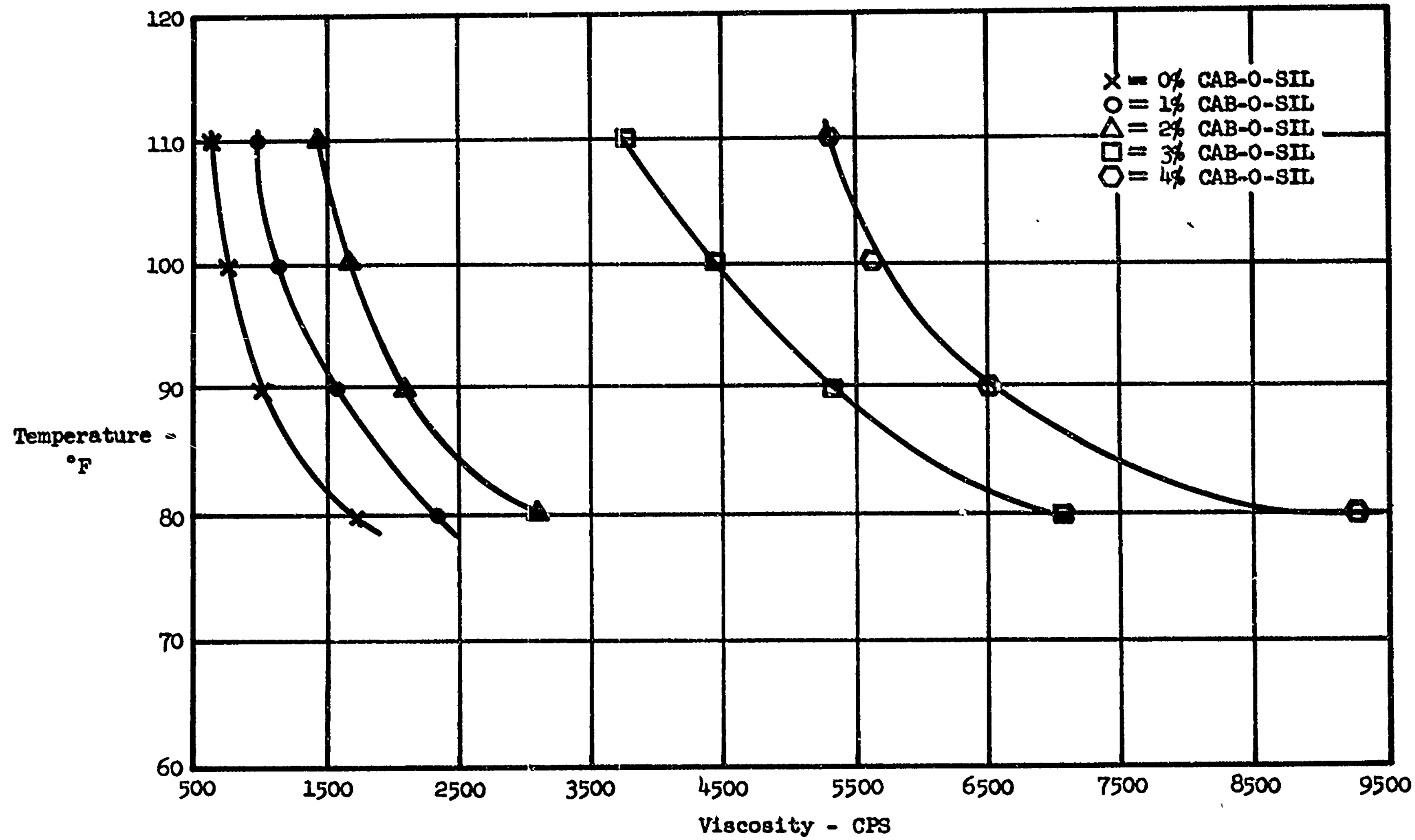


Figure 1. Viscosity Tests of Hetron 24689 With Various Concentrations of Cab-O-Sil

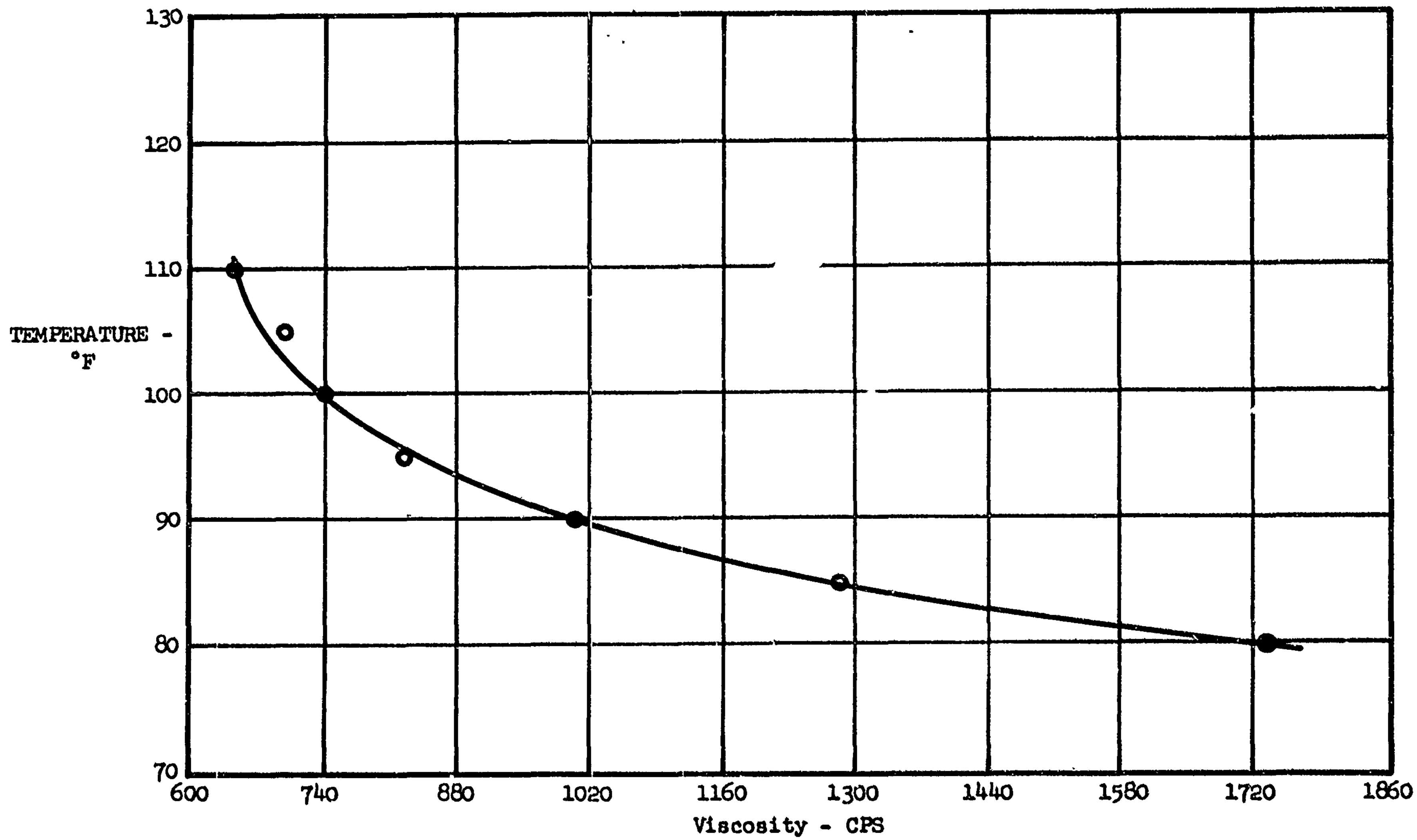


Figure 2. Viscosities of Hetron 24689 Without Cab-O-Sil

TABLE V GEL TIME IN MINUTES OF HETRON 24689 WITH VARIOUS CONCENTRATIONS OF PROMOTERS AND CATALYST

Promoter Concentrations (%)		Catalyst Concentrations, $MEKO_2$		
Co. Naph	DMA	0.5%	1.0%	1.5%
0.5	0	*	30	17
1.0	0	22	18	9
0.5	0.05	37	16	12
1.0	0.1	15	6	*

Note:

* Not Tested

Cab-O-Sil concentrations). One pound per square foot (227 gram) quantities of each mixture were poured onto the test setup and allowed to flow down the 30-degree incline. Figure 3, page 14 presents views of the 30-degree incline test setup, and a typical flow test. The flow rate was measured in inches per second. Figures 4, 5, and 6, pages 15 through 17, present the flow test results. The resin with 2% Cab-O-Sil flowed off the chart; therefore flow termination could not be recorded. The combination of six minutes gel time and four percent Cab-O-Sil had no flow.

C. FLUID RESISTANCE TESTS OF RAPID SITE MATERIALS

Rapid Site material specimens were subjected to various fluids to determine the effects, if any, of exposure to these fluids. Specimens were laid up using four parts Hetron 24689 resin to one part woven glass fabric and gun roving glass, to obtain a nominal two pounds per square foot thickness. A dam of vacuum sealing tape was built around the periphery of each test panel for all specimens, except for the specimens subjected to battery fluid. PR 702 sealant was used for the battery fluid specimens. The test fluids (nine) were poured on the surface of the specimens and allowed to remain for seven days. Three specimens were tested with each type of fluid, except for the MIL-L-7808C Lubricant, for which two specimens were tested. One set of three specimens was not subjected to any fluids and was used as a control sample for comparison. Upon completion of the fluid exposure period, flexural strength tests were conducted. Table VI, page 18, presents the results of these tests. Test runs were averaged to obtain the values listed in the table. All strength values were in the same range as the control sample, except for the brake fluid specimen values, which were somewhat lower. The lower flexural strength values were considered adequate, since there was no visual evidence of deterioration from the brake fluid.

D. TOXICITY TEST

The purpose of this test was to collect and analyze any vapors that might exude from confined cured Hetron 24505 resin, and relate them to any possible toxic effects on personnel.

A 24-inch square box was fabricated from Hetron 24505 Resin, with inlet and outlet tubes bonded at the extreme opposite corners of the box. The inlet was fitted with a flowmeter and regulator, and the outlet hose was attached to a liquid nitrogen cold trap. The system was protected from moisture by a drying tube connected to the cold trap outlet. Figure 7, page 19, presents views of this test setup. After completion of set up, the box was allowed to stand 18 hours - then purged using 600 liters of helium (107 grams) over a 6-hour period. This cycle was repeated on a 24-hour basis over a period of fourteen days. No samples were taken on Saturdays or Sundays. At the end of each purging period the cold trap was removed, the sample was weighed, and the residue subjected to infrared analysis. See Table VII, page 20, for toxicity test data. Figure 8, page 21, presents a plot of residue vs helium eluent. An infrared spectrum was made using a Perkin-Elmer Model 21 Infrared Spectrophotometer on the combination of all the samples, since the individual samples had similar spectra.

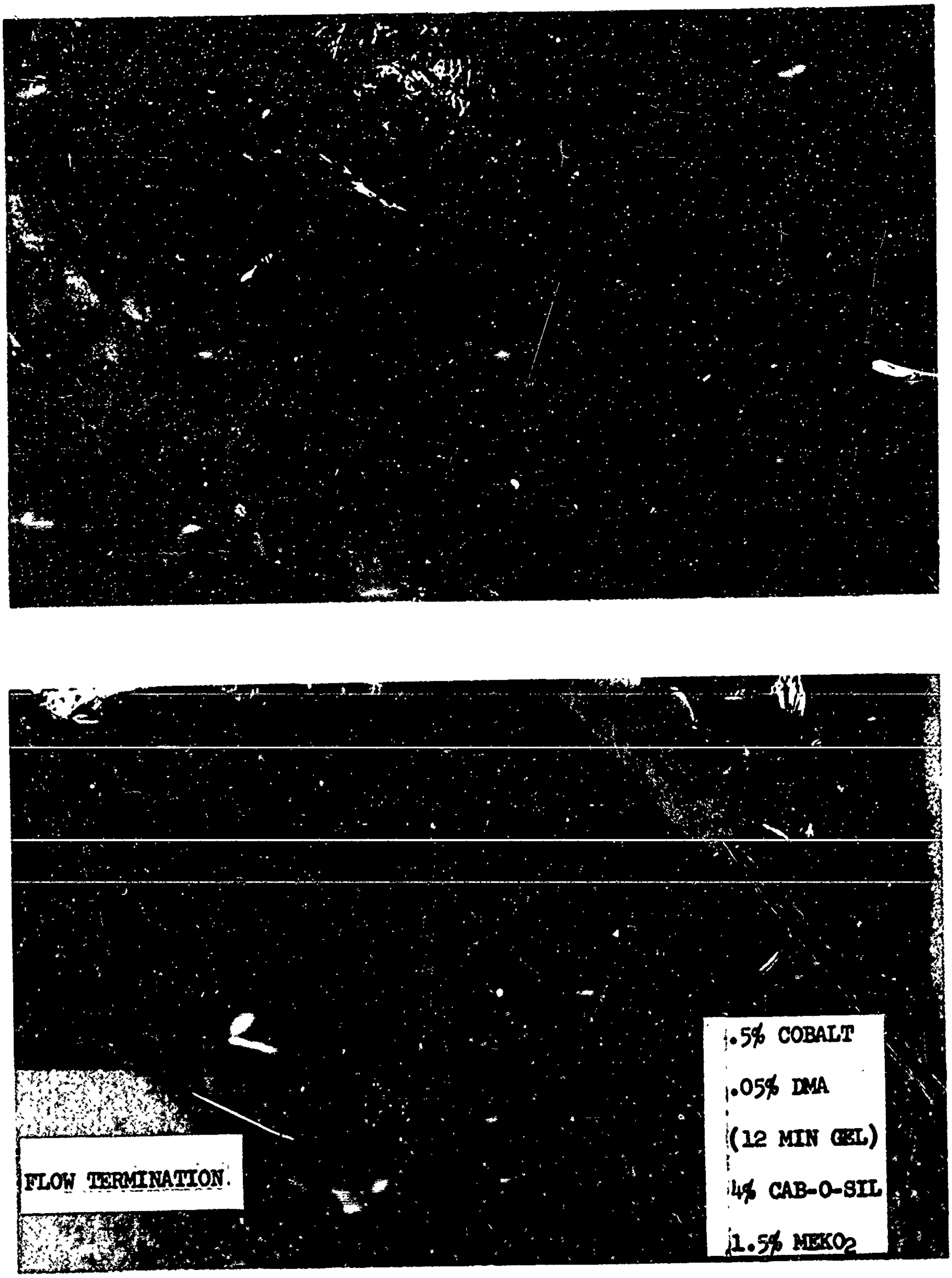


Figure 3. Views of the 30-degree Incline Flow Test Setup and Typical Flow Test

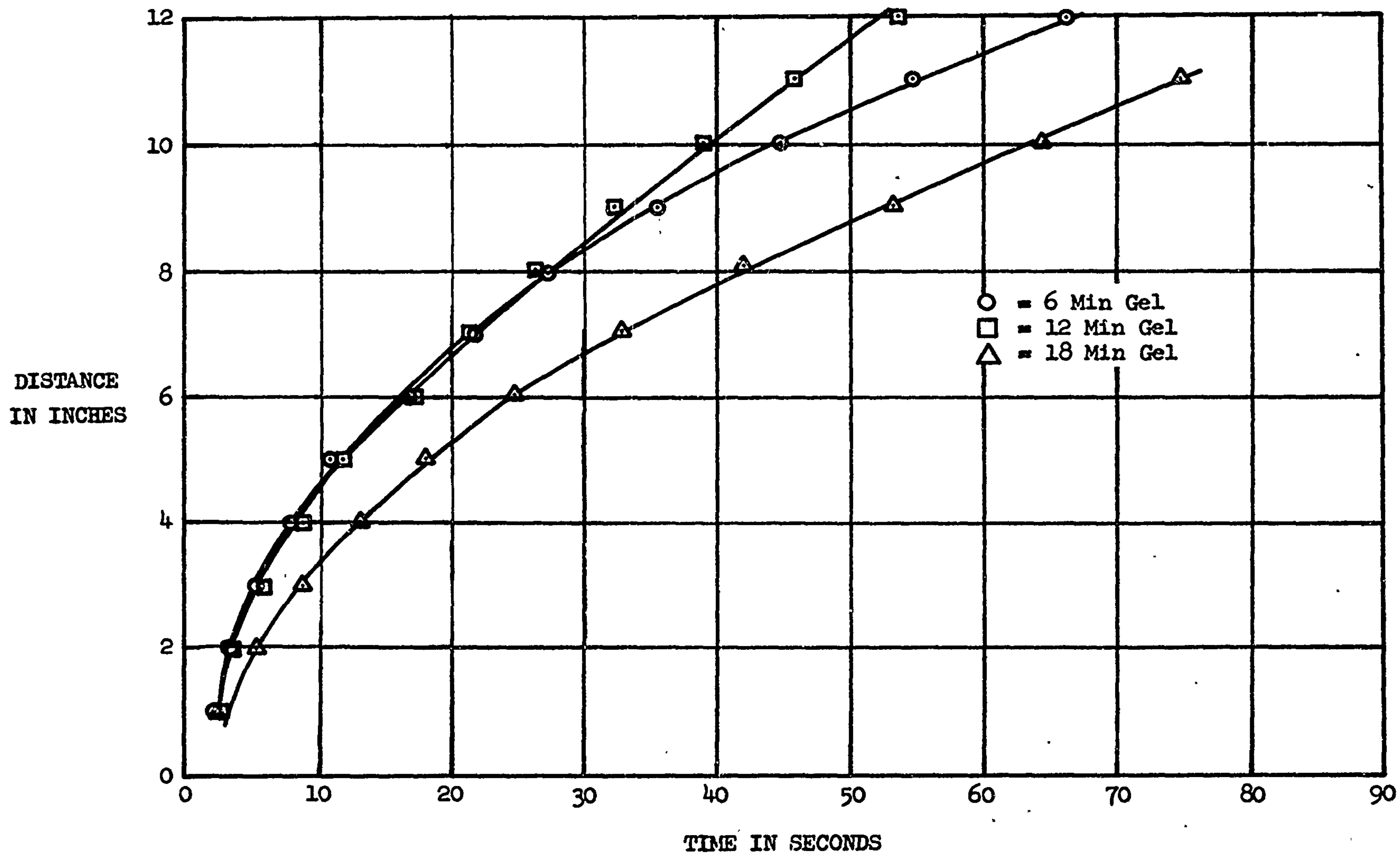


Figure 4. Flow Tests on 30-Degree Incline of Hetron 24689 With 2% Cab-O-Sil

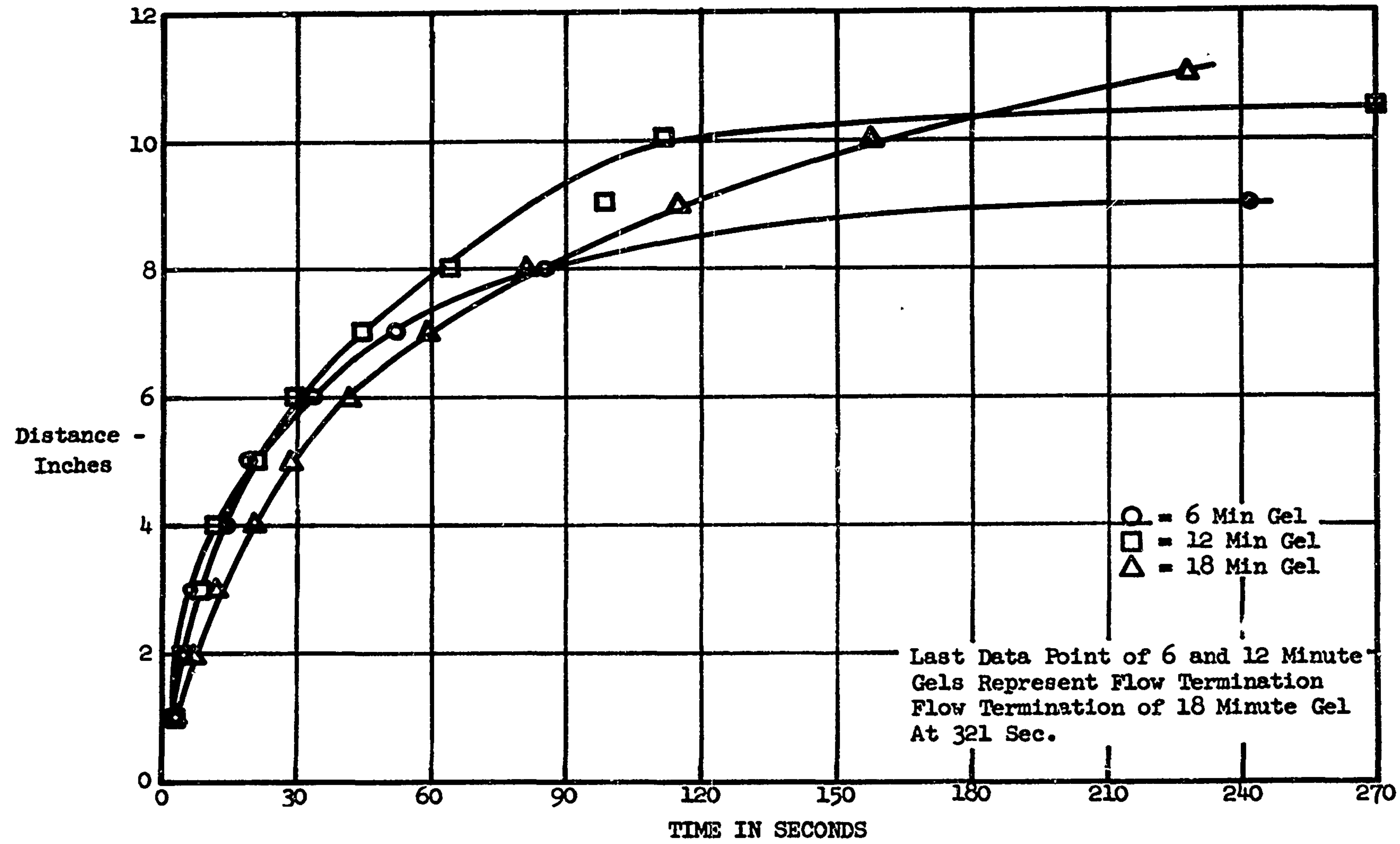


Figure 5. Flow Test on 30-Degree Incline of Hetron 24689 With 3% Cab-O-Sil

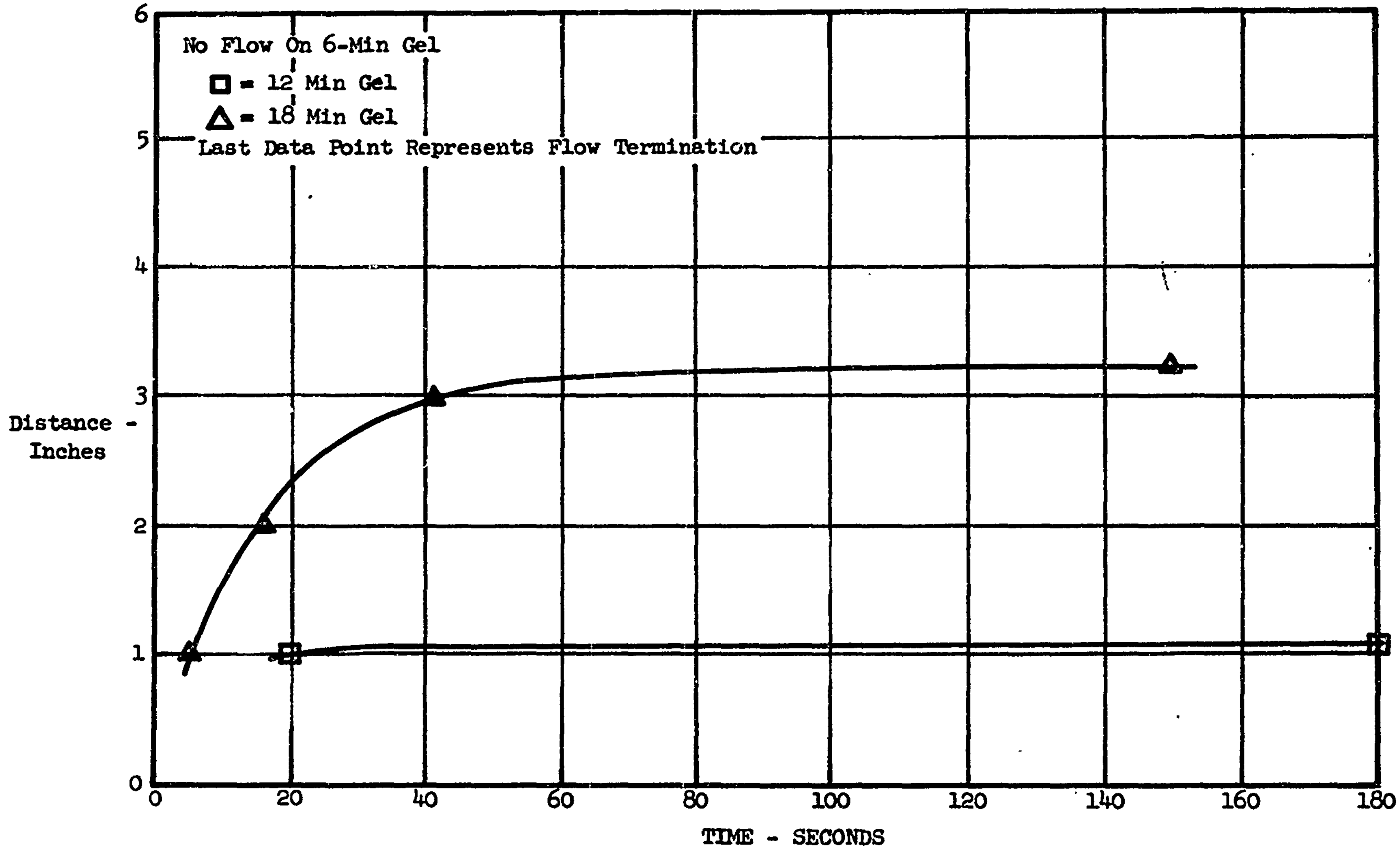


Figure 6. Flow Tests on 30-Degree Incline of Hetron 24689 With 4% Cab-O-Sil

TABLE VI FLEXURAL TEST RESULTS OBTAINED FROM THE TEST PANELS EXPOSED TO VARIOUS FLUIDS

Fluid Type	Flexural Strength (psi)
1. JP-4 Turbine Fuel	22,500
2. Aviation Gasoline	21,700
3. MIL-L-7808C Lubricant	22,500
4. MIL-H-5606 Hydraulic Fluid	24,900
5. Ethylene Glycol Antifreeze	23,600
6. Dilute Sulfuric Battery Acid	25,600
7. Water	22,400
8. Motor Oil	22,250
9. Automotive Brake Fluid	16,300
10. Control Sample	21,900

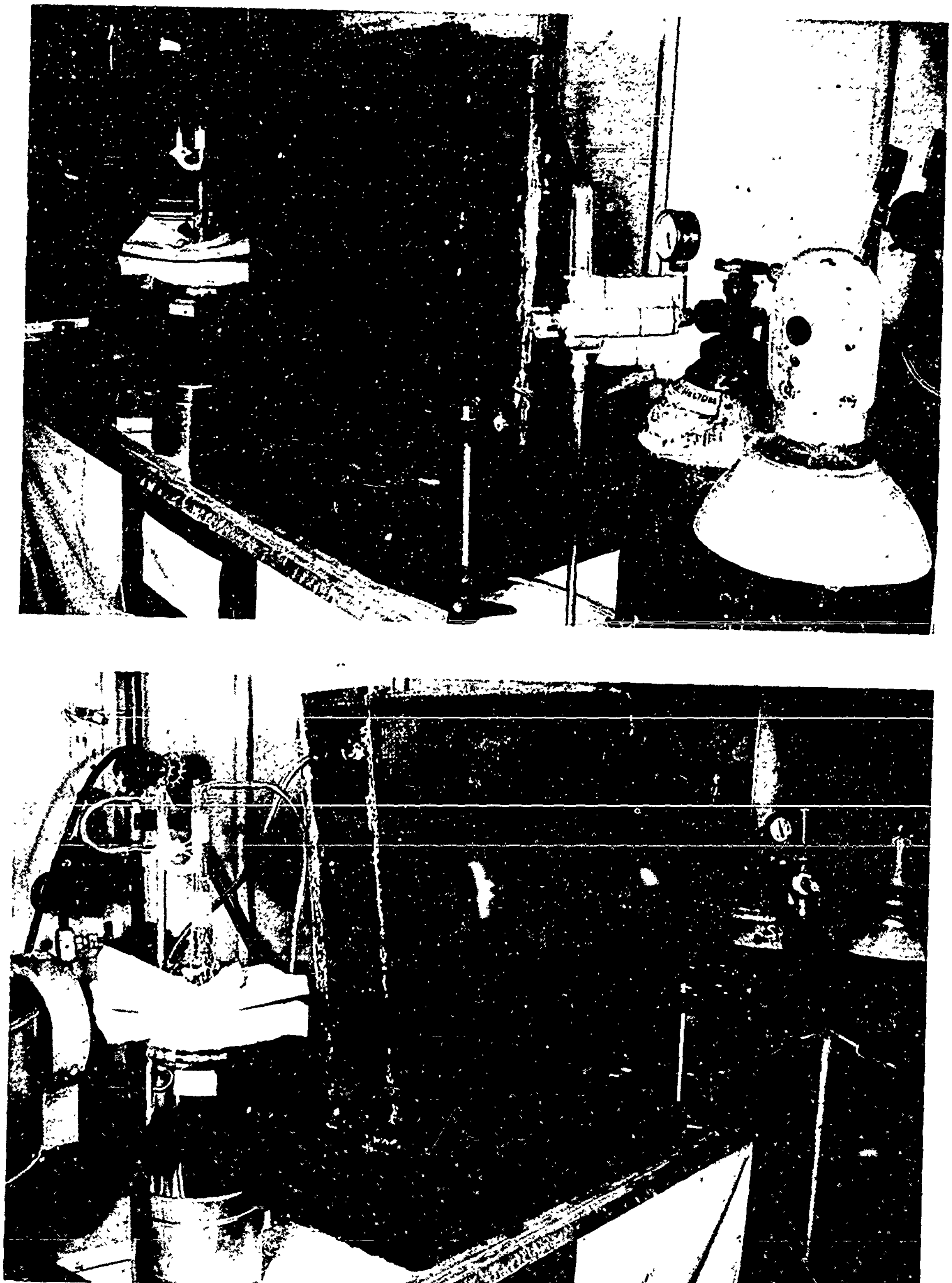


Figure 7. Views of the Toxicity Test Setup

TABLE VII TOXICITY TEST DATA

Sample No.	Day	Weight of Residue (Micrograms)	Weight of Helium Eluent (Grams)
1	Thurs.	640	107
2	Fri.	380	107
3	Mon.	200	107
4	Tues.	*	107
5	Wed.	560	107
6	Thurs.	330	107
7	Fri.	620	107
8	Mon.	600	107
TOTAL		3330	856

Notes:

No evidence of styrene was observed.

Concentration of vapor in Eluent $= \frac{.003330 \text{ Grams}}{856 \text{ Grams}} = 4.45$ ppm

* The sample in Run No. 4 apparently evaporated before a weight was obtained. A positive identification of the mixture was not possible because of the small amount of material present.

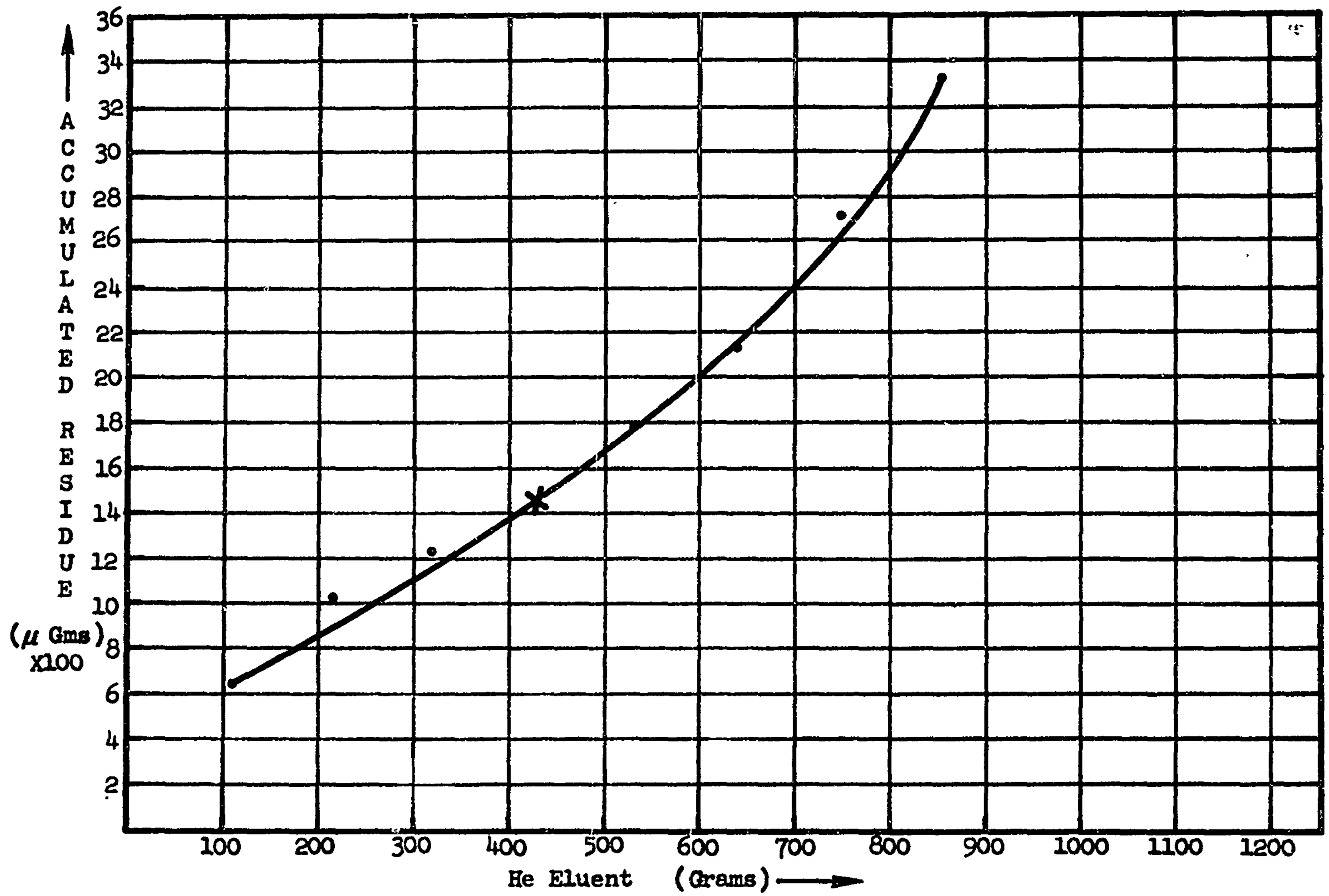


Figure 8. Residue Vs Helium Eluent

An anlysis of residual volatiles from the surface of cured Rapid-Site panels was conducted to determine the presence and concentration of harmful components. These tests were conducted primarily to confirm or deny the presence of styrene and/or methylethylketone peroxide vapors. The total volatile elution concentration was less than five parts per million (ppm). There was no evidence of either styrene or peroxides in the eluent condensate. The entire condensate was apparently composed of aliphatic hydrocarbons and a trace of alcohol (or water).

Styrene, which comprises 20 to 30 percent of the unpolymerized resin, can be hazardous in high concentrations. Eye and nasal irritation was reported in small animals with concentrations on the order of 1300 ppm in Dangerous Properties of Industrial Materials, by N. Irving Sax.

Of more practical significance is the threshold value of 100 ppm recommended in Threshold Limit Values, by the American Conference of Government Industrial Hygienist. This value represents "conditions under which it is believed that nearly all workers may be repeatedly exposed, day after day, without adverse effect." The Merck Index states that this material is irritating to the eyes and mucous membranes in high concentrations but does not define specific limits.

During polymerization, all or nearly all styrene should be reacted with the resin. This should be particularly true of Hetron 24505 resin as the manufacturer reports less than stoichiometric concentration of styrene.

Methylethylketone peroxide is added to the resin in 0.5 to 1% concentration to effect polymerization. Toxic levels of methylethylketone peroxide are not well documented. A listing which is based on the Journal of Industrial Hygiene Association describes a maximum allowable concentration of Lupersol DDM (MEK peroxide 60% in dimethyl phthalate) of 250 ppm. This would correspond to roughly 30 ppm of hydrogen peroxide. Obviously this assumes only short periods of exposure. The threshold value is only 1 ppm hydrogen peroxide or 8.5 ppm Lupersol DDM. It is probable that all of the peroxide is decomposed during polymerization of the resin.

The following conclusions are drawn based on the findings of the referenced investigators:

1. Cured Rapid-Site resin is not likely to cause adverse effects to personnel operating in proximity thereof.

2. Good ventilation should be provided during all fabrication operations to prevent excessive concentration of vapors of unreacted resin or catalyst.

E. SUITCASE FIELD LABORATORY

A self-contained field suitcase laboratory was developed, fabricated, and used in SEA. This unit contained all the equipment and chemicals necessary to determine resin stability, viscosity and gel time, and the

active oxygen content of methylethylketone peroxide. The portable laboratory included items as follows:

1. Triple beam balance
2. Portable viscometer
3. Thermometers
4. Durometer (Shore D)
5. Ring stand
6. Burettes
7. Titration flasks
8. Standardizing reagents ($K_2Cr_2O_7$, .136N)
9. Titration reagent ($Na_2 S_2O_3$)
10. KI
11. Thyodene indicator
12. Pipettes
13. Syringes
14. Graduated cylinder (10 ML)
15. Deionizer resins for H_2O_2
16. Iso-propanol-acetic acid

Views of the laboratory are presented in Figure 9, page 24. At completion of the SEA site construction program, the portable laboratory was returned to LTV, Dallas, Texas.

F. MATERIAL TESTS IN SOUTHEAST ASIA

Prior to spraying resin, initial tests were conducted in SEA on the resin and catalyst, and both were found to be in good condition and acceptable for use. Promoters were not included in the resin as shipped to SEA to insure good storage characteristics. Therefore, trial samples of the resin with various promotion levels added were tested to determine the promotion addatives required to achieve the desired gel time and hardening characteristics. The addition of five pints of Cobalt Naphthenate per 55 gallon drum of resin produced the desired results, and was therefore used for promotion of all the resin used in all of the SEA sites. One drum of resin was allowed to set out in the sun, and was checked periodically for evidence of deterioration. No evidence of deterioration was found.

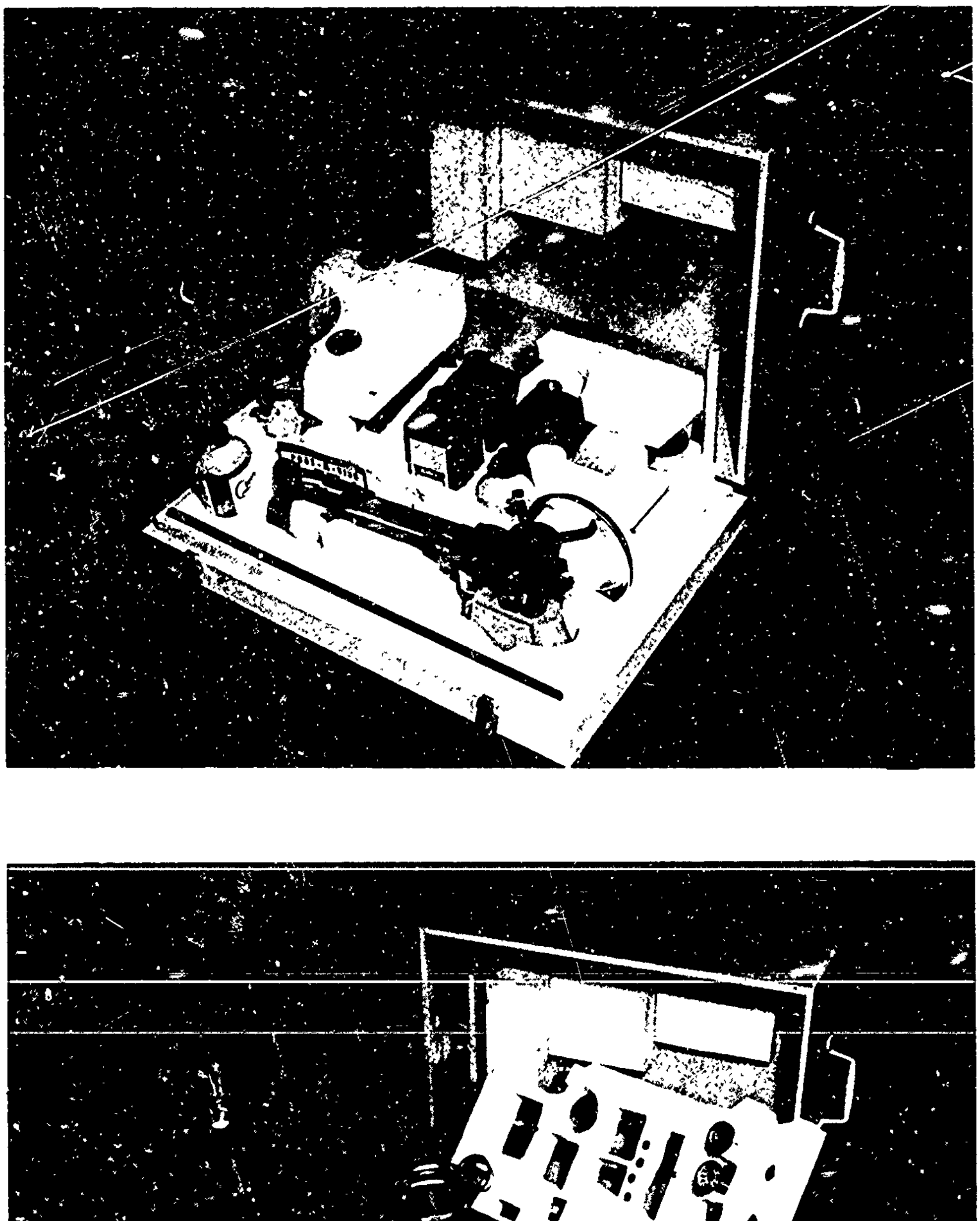


Figure 9. Views of the Suitcase Laboratory

The catalyst (MEK peroxide), which was stored in an air-conditioned environment, was also checked periodically during the program and found to be acceptable for use. Many of the catalyst containers leaked during storage, but samples tested from these containers were still acceptable for use. Catalyst tests were conducted to determine the catalization levels required during construction of the test sites. As a result of these tests, catalyst system flow rate settings were determined. These settings were varied, as required, to obtain the desired gel times during construction of the sites. Meter settings ranged between 30 and 95 percent, depending upon such factors as the resin flow rate, temperature, and sun conditions. Catalyst concentrations ranged between 0.5 and 1.6 percent.

SECTION IV

TEAM TRAINING AND FIELD TESTING AT LTV

Field testing was conducted, as necessary, to train the LTV SEA Team and develop techniques for SEA operations. Training was started upon selection of the LTV SEA Team members. After initial discussions on the various aspects of the Rapid Site System (construction methods, materials, equipment, safety considerations, etc.) team members were introduced to the application equipment. This included familiarization as follows:

1. Actual truck driving including power takeoff operation.

2. Actual spraying of glass and servicing of the glass pot.

3. Actual rollout of the woven roving fabric using the woven glass dispensing equipment.

4. Getting the feel of the resin pole gun (without actually spraying resin).

5. "Dry run" operation of the various controls on the resin, air, catalyst, and solvent systems.

6. Operation of the public address system.

7. Servicing of the catalyst and solvent pots.

8. Resin trailer operation, filling, mixing, and cleaning.

9. Resin transfer pumping unit operation.

The last phase of team training involved actual site construction, using experienced personnel working along with inexperienced team members. During this phase of the program, techniques were developed for use in SEA.

Three types of field testing were accomplished, as follows:

1. Sand revetment

2. Sand bag emplacement

3. Flat surface (C-130 airplane) pads

A simulated sand revetment section was constructed which is shown in Figure 10, page 28. Three types of sand revetment coverage (resin only, resin and spray glass, and resin and woven glass fabric) were tested. Footprints in the sand were raked out before spraying some of the test sections, and were allowed to remain for others. Figures 11 and 12, pages 29 and 30, show views of the sand revetment test site during and after completion of spraying operations. All surfaces sprayed supported foot traffic with no

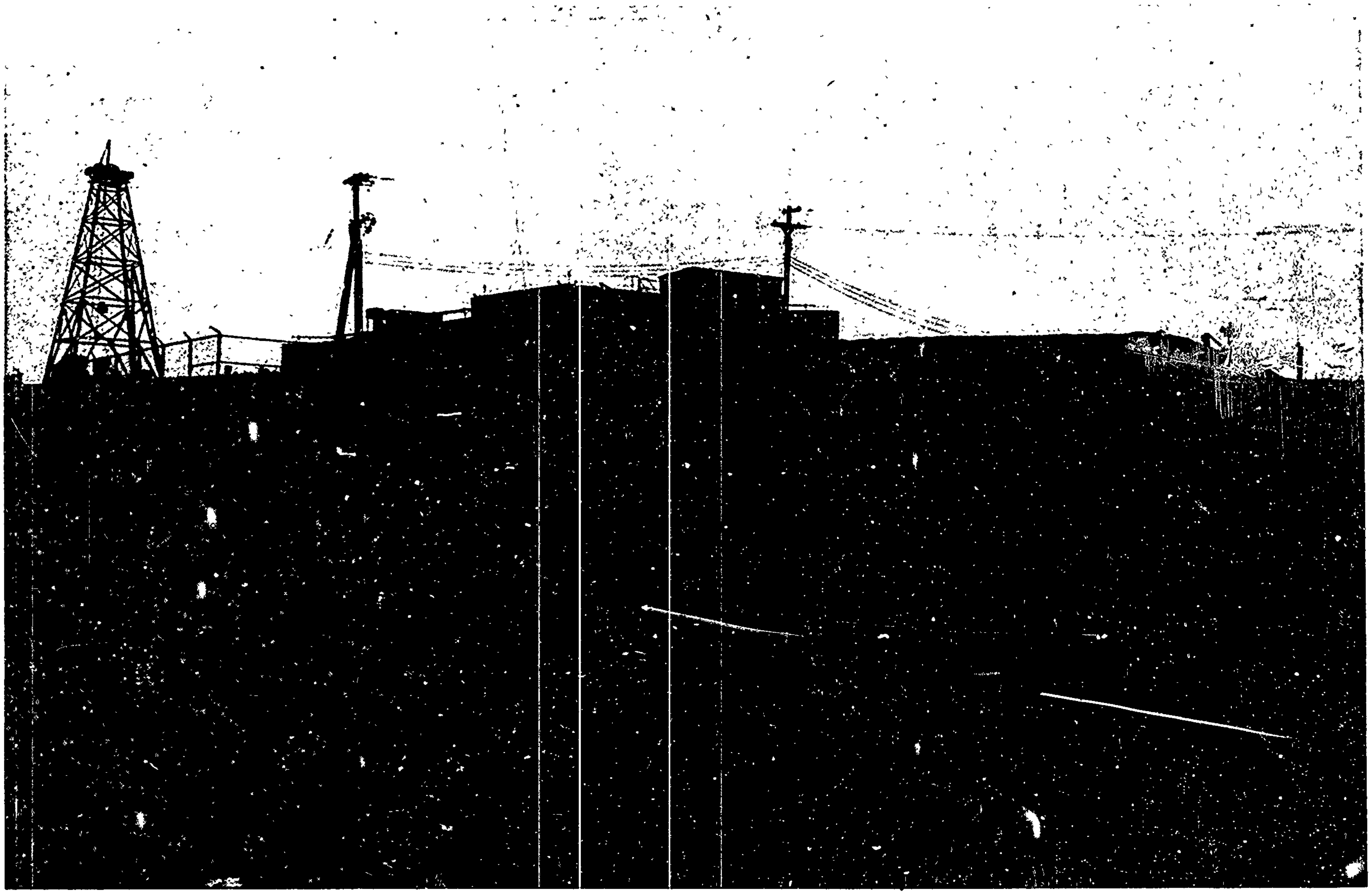


Figure 10. View of the Sand Revetment Constructed For Southeast Asia Team Training

Figure 11. View of Sand Revetment During Spraying Operations

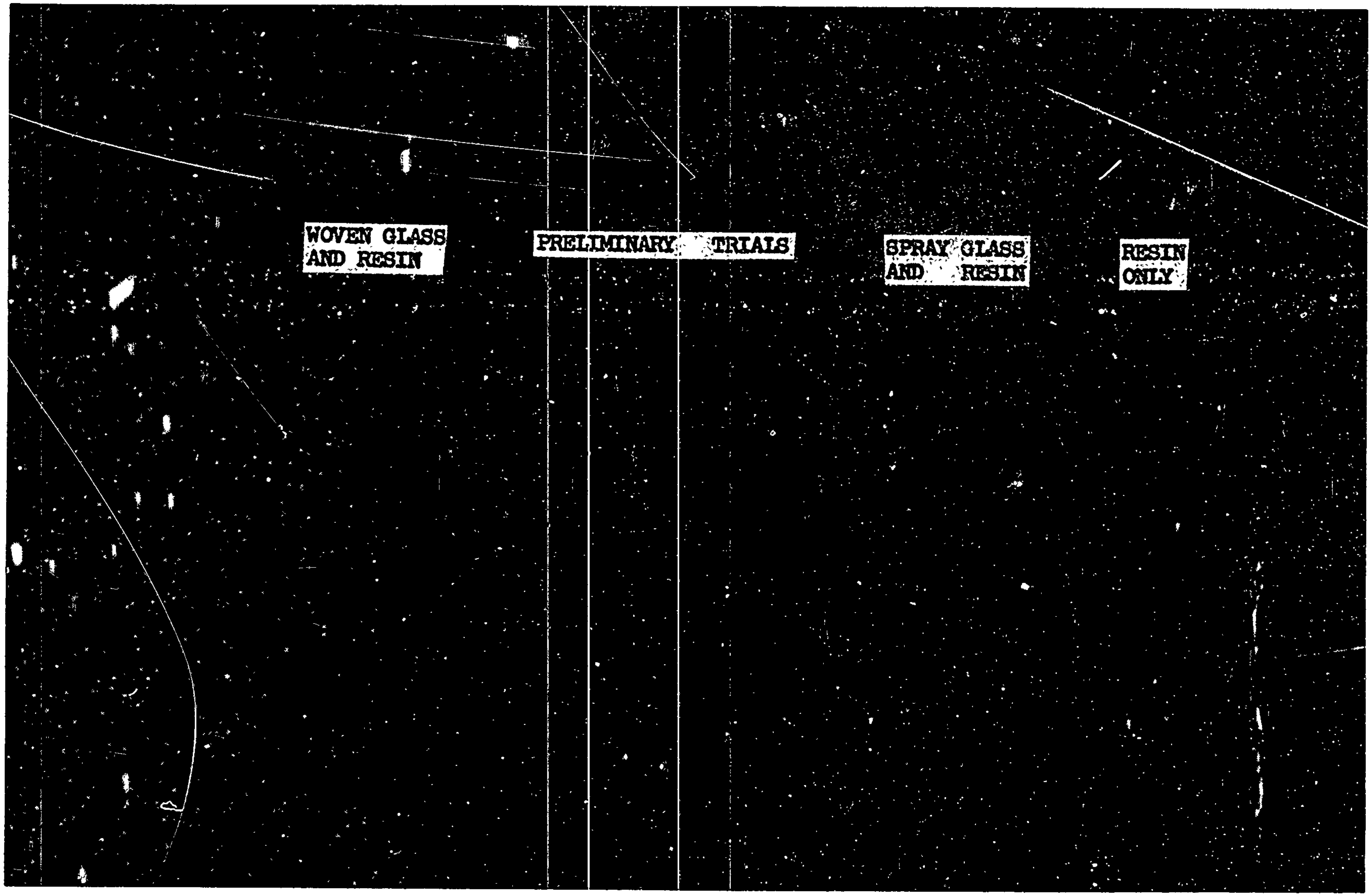


Figure 12. View of Sand Revetment at Completion of Testing

evidence of cracking or failure. The test conditions and detailed test results are presented in Table VIII, page 32.

A simulated sand bag emplacement was constructed, which is shown in Figure 13, page 33. All areas of the emplacement were sprayed, except the ceiling. A compressed air breathing apparatus was used for spraying inside, with good results. Figures 14 and 15, pages 34 and 35, show views of the sand bag emplacement during and after completion of the spraying operations. Four types of coverage were used (resin only, Cab-O-Sil filled resin, resin and spray glass, and resin and woven glass). Three types of resin guns (LTV, Glasscraft hand gun, and Glasscraft pole gun) were used. The combination of Cab-O-Sil filled resin (two percent concentration) with the Glasscraft pole gun gave the best looking results for wall coverage. Roof construction of gun roving glass and resin followed by one layer of woven roving glass fabric covered with more gun roving glass and resin was very satisfactory. See Table IX, page 36, for detailed test results.

Flat surface pads were constructed and subjected to simulated C-130 rolling wheel loads testing. Figure 16, page 37, shows views of a combined resin and spray, glass system (operated by one man) which was developed during these tests. Using this combined system - along with a new, larger glass pot (feeding glass from two rolls simultaneously), a much higher percentage of spray glass in the pad was achieved. Spray glass percentages up to 17.4 were obtained, compared with around four percent for the usual method. Hand rolling was necessary to adequately wet the increased amount of spray glass. These pads were constructed on two types of soil, as follows:

1. Soil number 1, washed sand (classification SP, CBR approximately 2.0)

2. Soil number 2, gray clay (classification CH, CBR approximately 0.6)

Figure 17, page 38, shows a layout of the C-130 airplane pads. Table X, page 39, gives pertinent details for the test vehicle used on these tests. Figures 18 through 21, pages 40 through 43, show views of the testing. Table XI, page 44, presents the pad construction, test conditions, and results.

TABLE VIII LTV SAND REVETMENT TEST CONDITIONS AND RESULTS

No.	Type of Construction	Resin Flow Range	Resin Guns	Density (lb/ft^2)	Note	Results
1	Resin only	2 to 5 gpm	LTV and Glasscraft pole gun	1 and 2	(d)	All methods produced satisfactory looking coverings.
2	Resin and spray glass	2 to 5 gpm	LTV and Glasscraft pole gun	1 and 2	(a) and (b)	All methods produced satisfactory looking coverings. (LTV gun preferred—using 2 gpm flow rate combined with glass gun)
3	Resin and woven glass	2 to 5 gpm	LTV and Glasscraft pole gun	1 and 2	(c)	All methods produced satisfactory looking coverings (either resin gun satisfactory)

Notes:

(a) Large and small glass pots were used.

(b) Separate and combined resin and glass guns were used (see Figure 16, page 37 for a view of a typical combined spraying system (operated by one man).

(c) Locating the heavy glass rolls on the hillside was very difficult in the deep sand.

(d) At the higher flow rate (5 gpm) the resin puddled and ran using a 2 lb/ft^2 single pass covering.

See Figures 10, 11, and 12, pages 28 through 30 , for views of this test.

Figure 13. View of the Sand Bag Emplacement Constructed for Southeast Asia Team Training

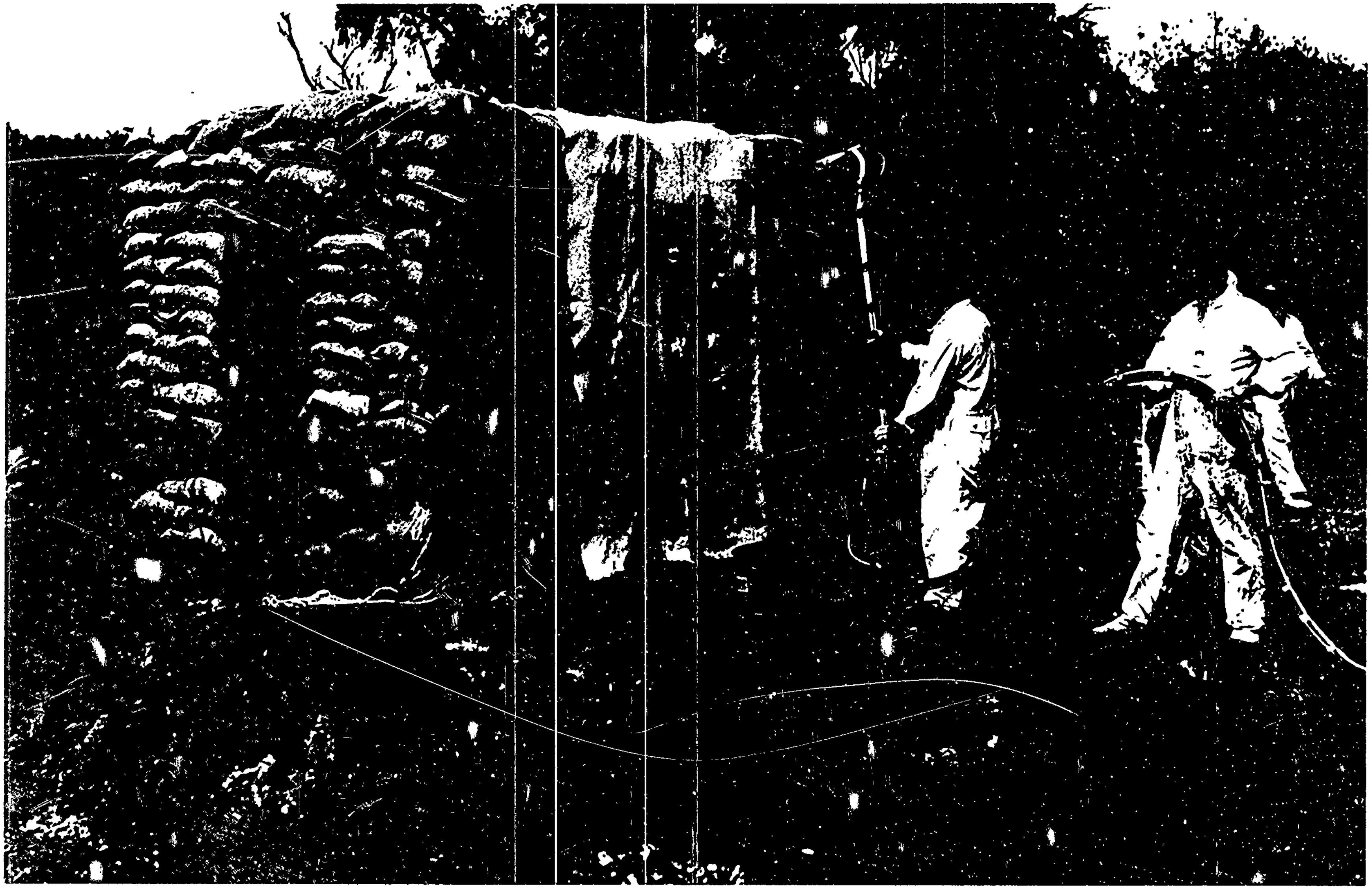


Figure 14. View of Sand Bag Emplacement During Spraying Operations

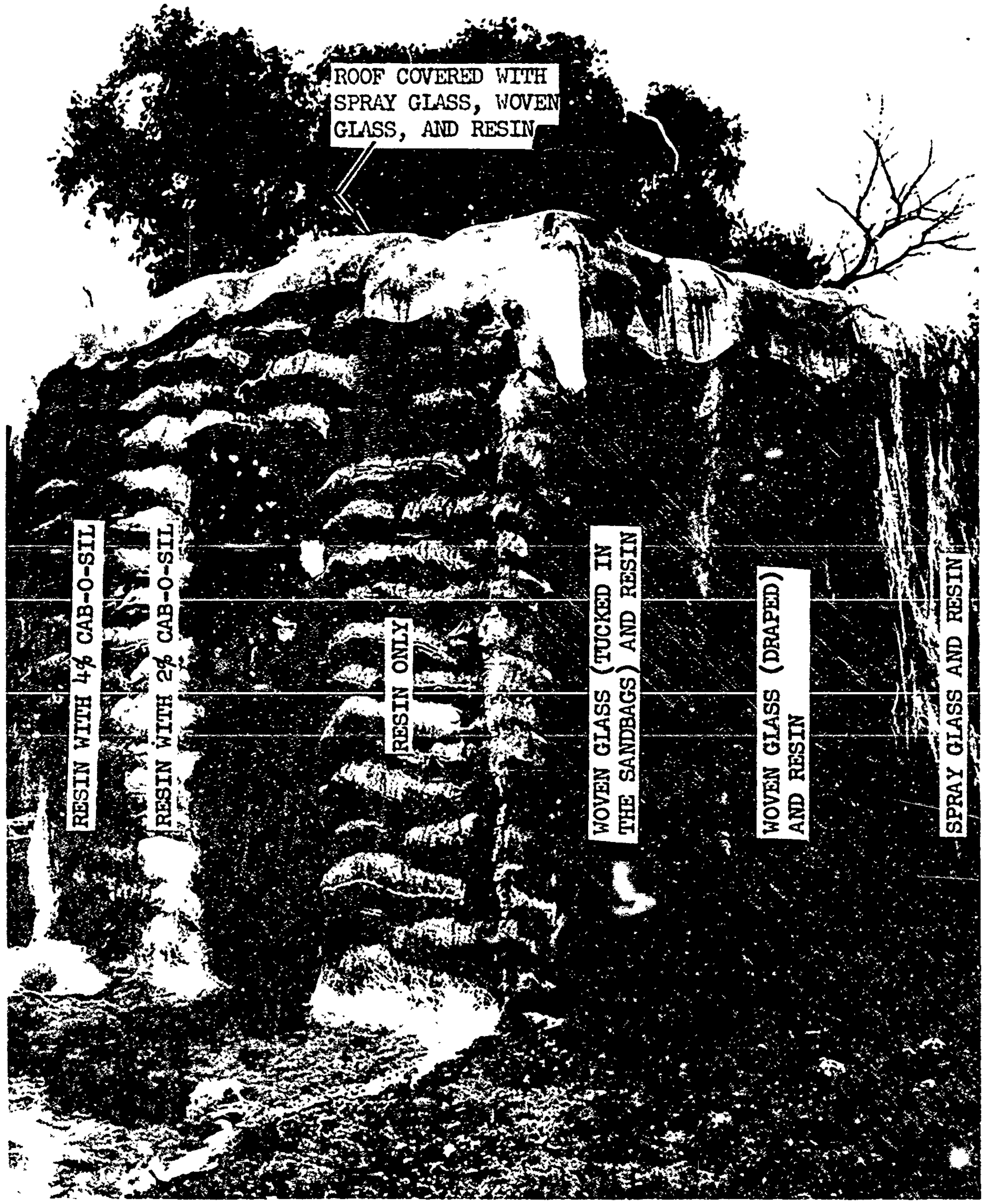


Figure 15. View of Sand Bag Emplacement at Completion of Testing Showing Typical Types of Construction

TABLE IX LTV SAND BAG EMPLACEMENT TEST RESULTS

No.	Type of Construction	Resin Flow Range	Resin Guns	Density (lb/ft^2)	Note	Results
1	Resin only	0.5 to 2.5 gpm	LTV, Glasscraft pole gun, and Glasscraft hand gun	1	(b)	Looked good except for some pin holes that occurred.
2	Cab-O-Sil filled resin only	2.3 gpm	LTV and Glasscraft pole gun	1	(b)	Looked good-(4% Cab-O-Sil was too thick, 2% was about right) No evidence of pin holes observed.
3	Resin and woven glass	2.5 gpm	LTV and Glasscraft pole gun	1	(a) and (b)	Looked good - Tucking in woven glass was difficult.
4	Resin and spray glass	0.5 to 2.5 gpm	LTV, Glasscraft pole gun, and Glasscraft hand gun	1	(b)	Not very satisfactory on vertical walls (Hard to keep the spray glass from falling off the walls.)

Notes:

(a) Standard woven glass (1.5 lb/yd^2) was used. Also small pieces of trevarno 2P-161 and 3P-146 tooling cloth were used with good results.

(b) The Glasscraft pole gun worked best for all wall areas of the sand bag emplacement.

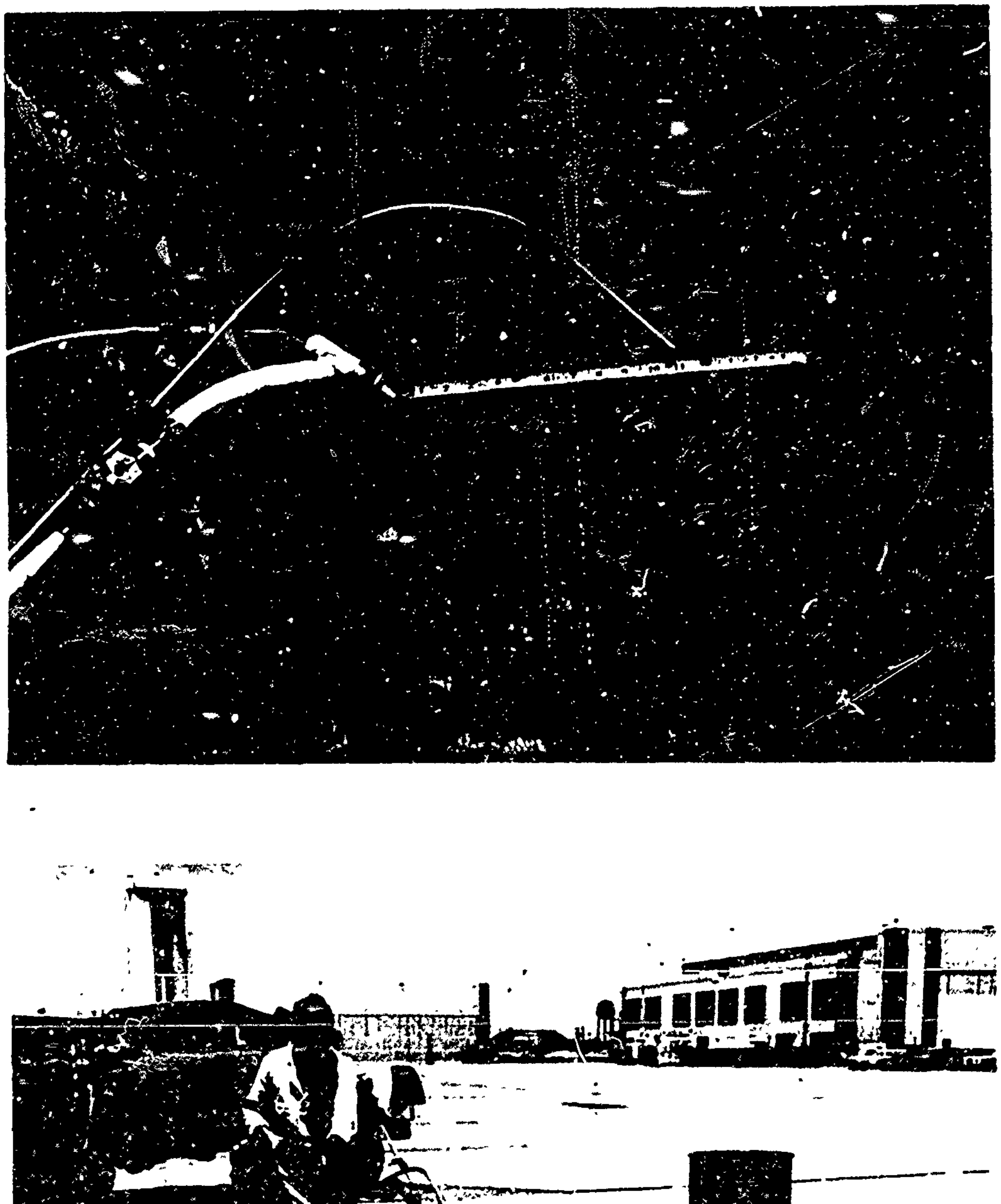


Figure 16. Views of Equipment and Method Used for One-Man Combined Resin and Glass Spraying Operation

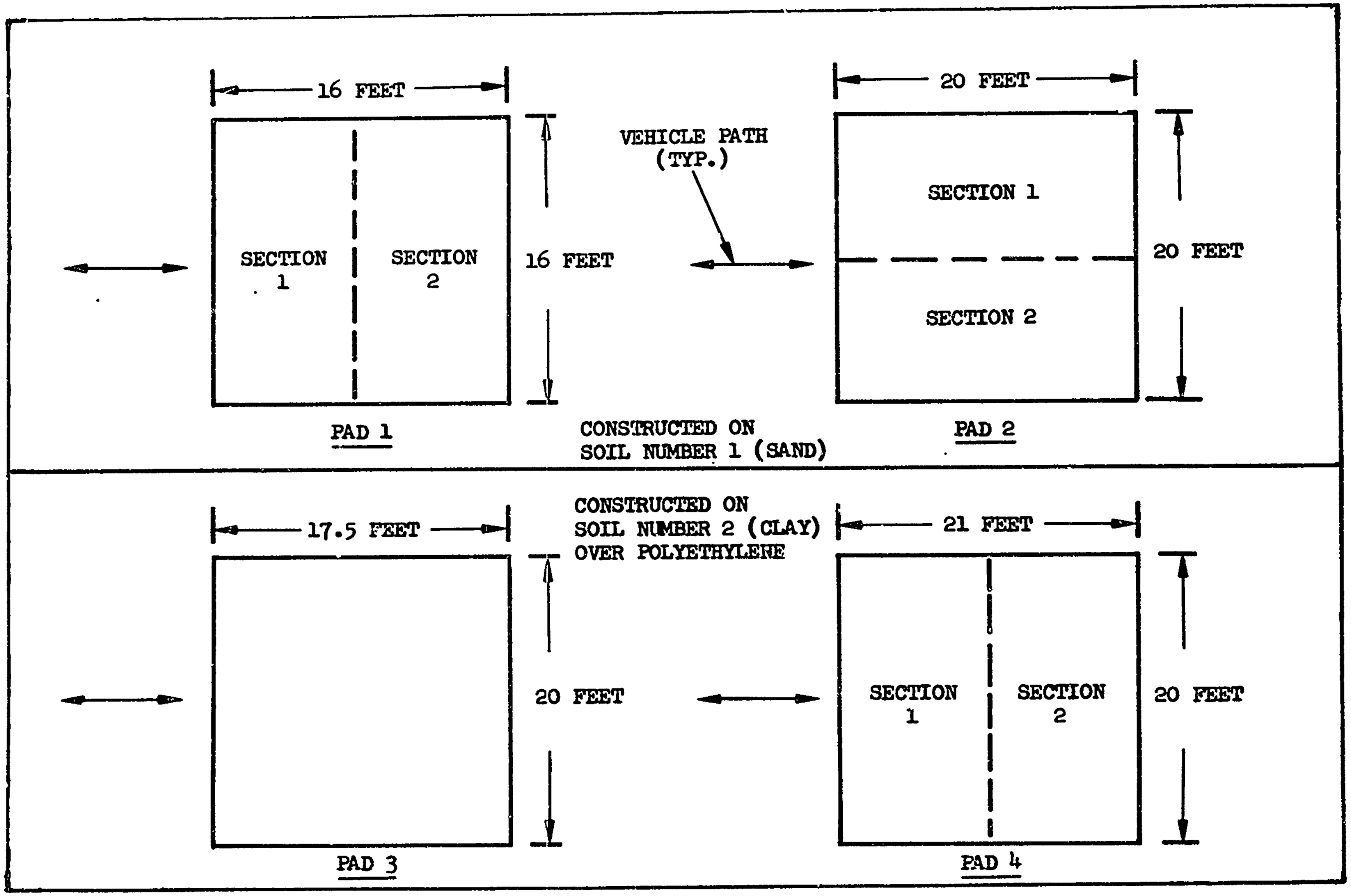
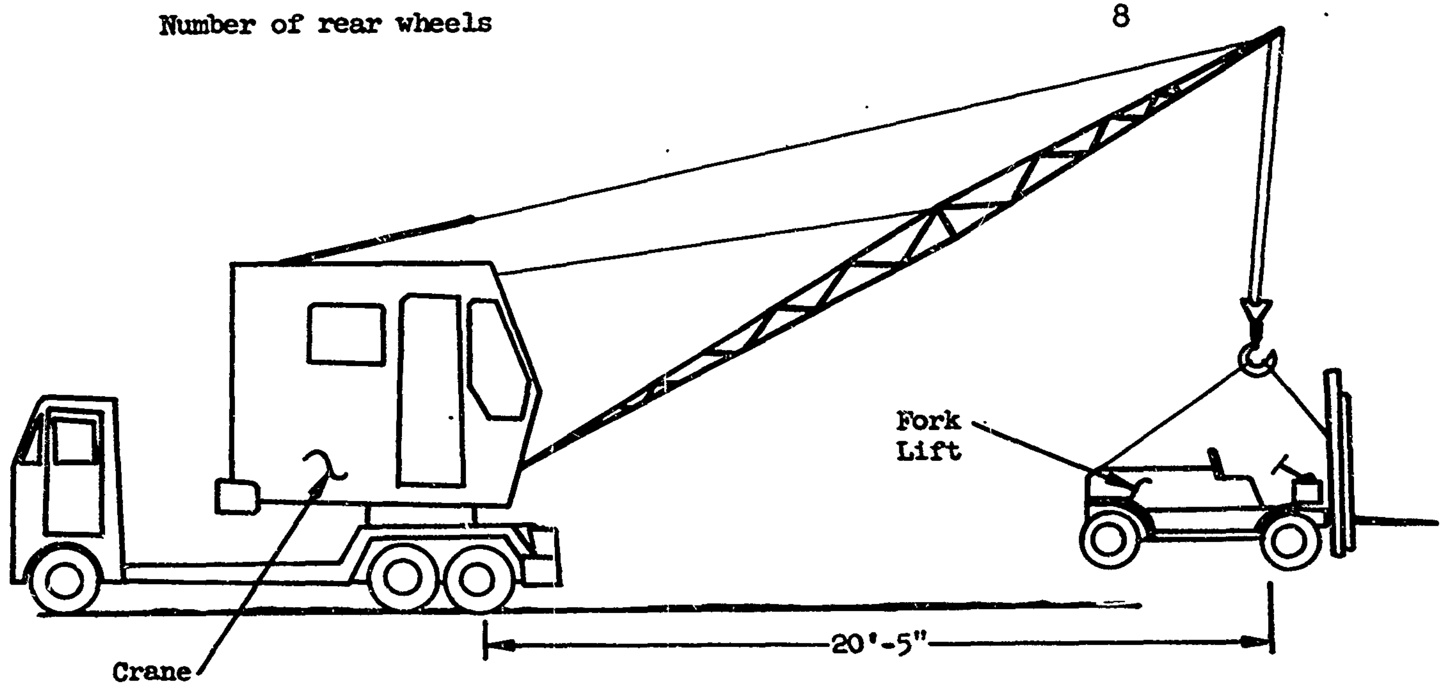
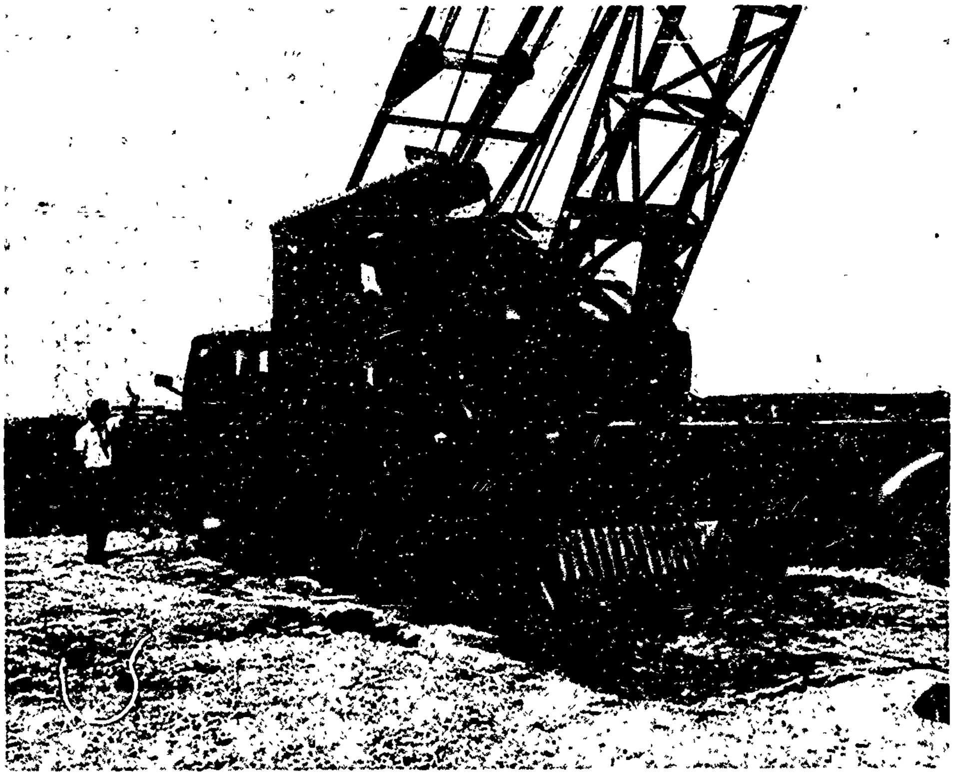


Figure 17. Test Pads Constructed for Simulated C-130 Airplane Rolling Wheel Testing

TABLE X TEST VEHICLE DATA FOR SIMULATED C-130 AIRPLANE ROLLING WHEEL TESTS

Weight of crane (unloaded)	86,000 lb
Weight on Rear Axles (loaded)	100,000 lb
Weight of fork lift (used for load)	19,750 lb
Crane tire size	9.00 x 20 inches
Crane tire pressure	95 psi
Crane tire contact area (each)	10.5 x 15.5 inches
Number of rear wheels	8





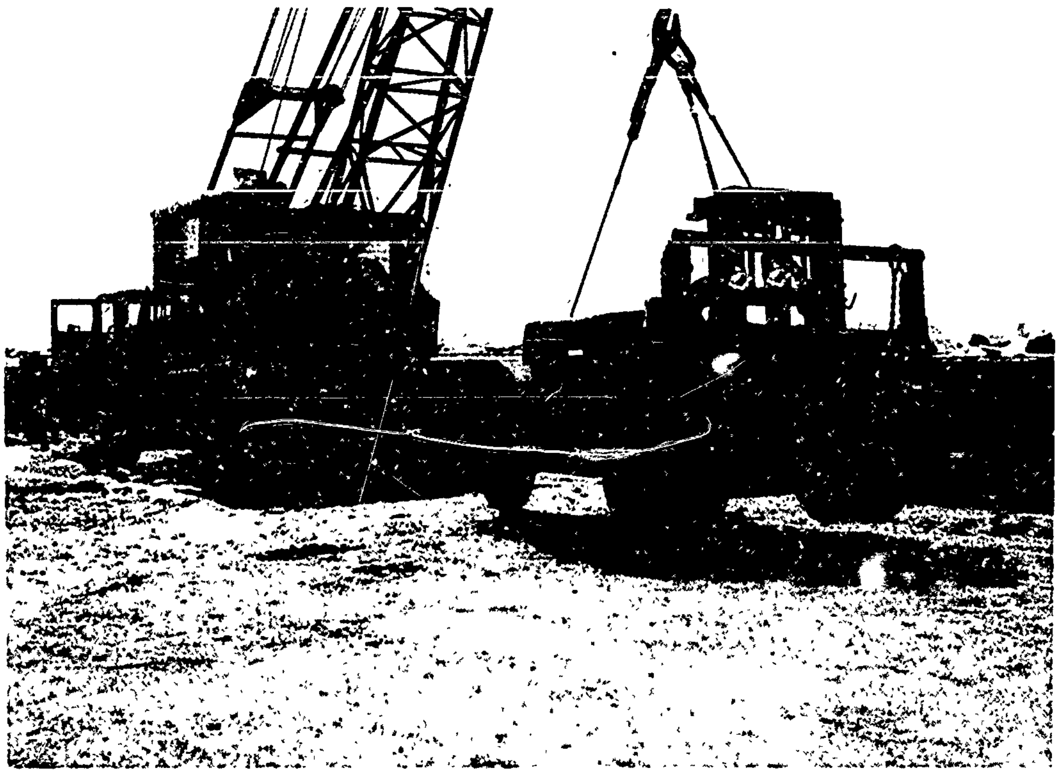
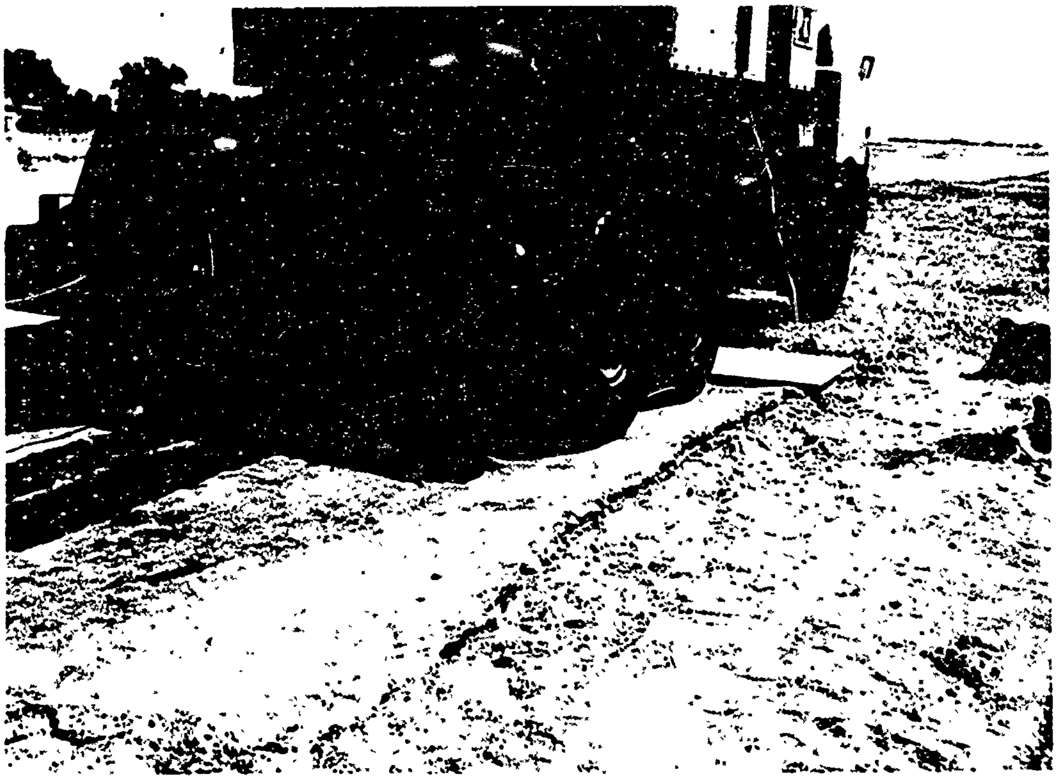


Figure 18. Views of Testing of Simulated C-130 Airplane - Pad 1 on Soil 1 (Sand)



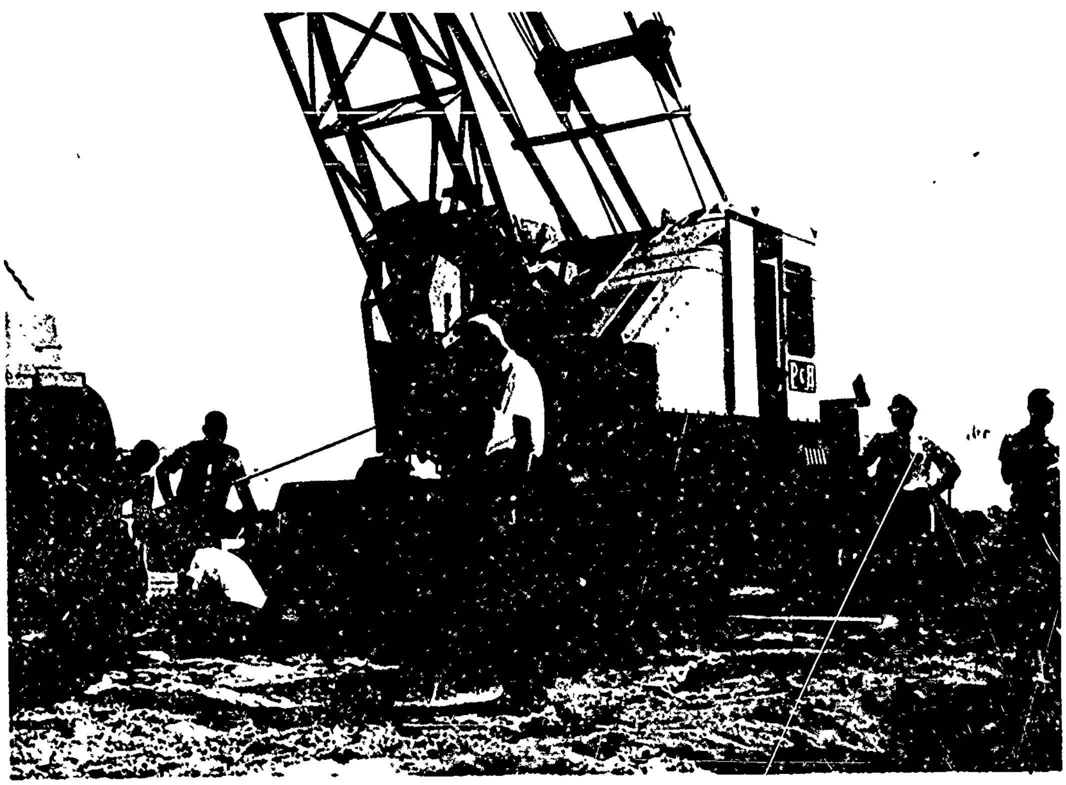


Figure 19. Views of Testing of Simulated C-130 Airplane - Pad 2 on Soil 1 (Sand)

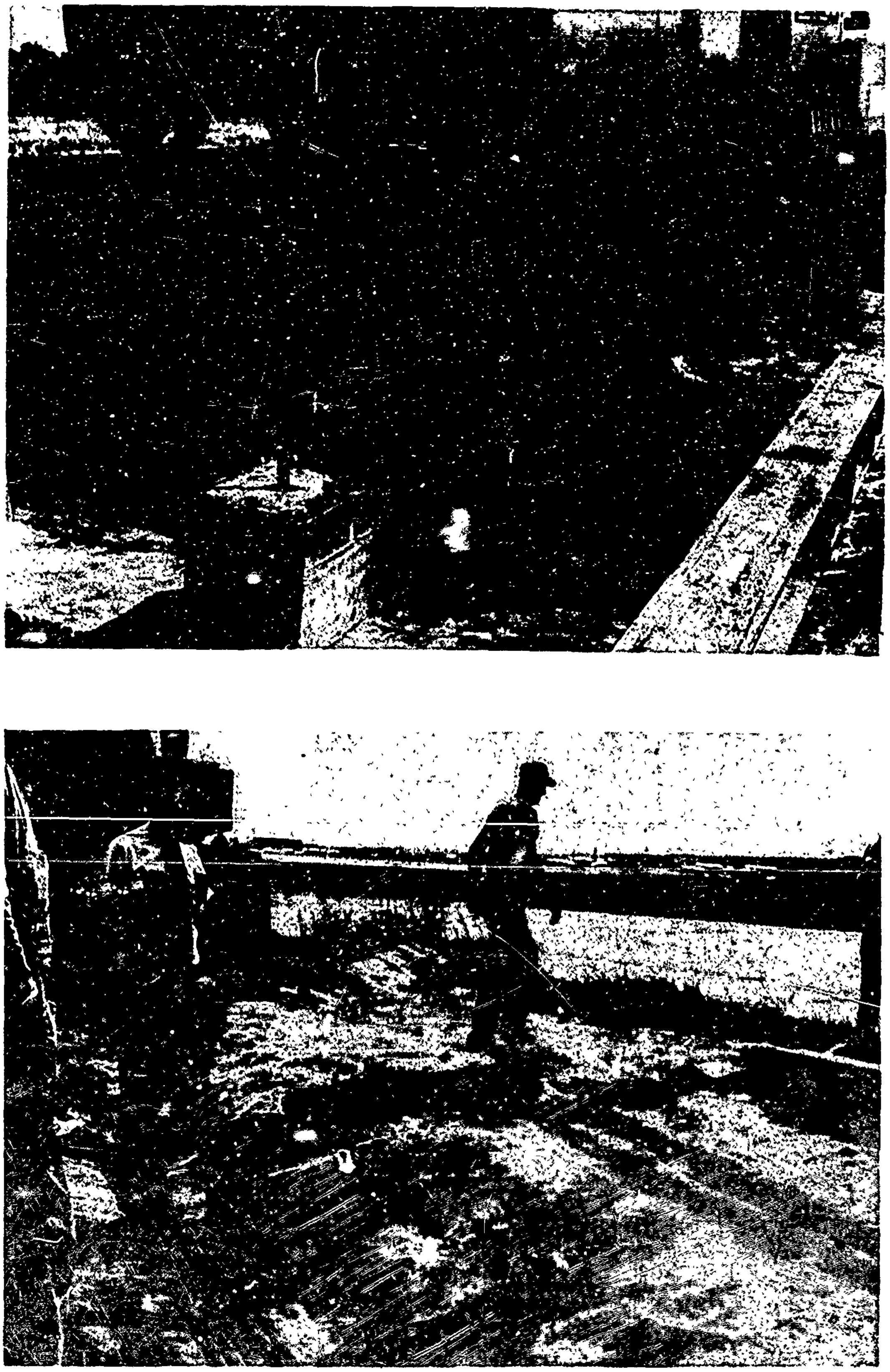


Figure 20. Views of Testing of Simulated C-130 Airplane - Pad 3 on Soil 2 (Clay) in the Soil Trench

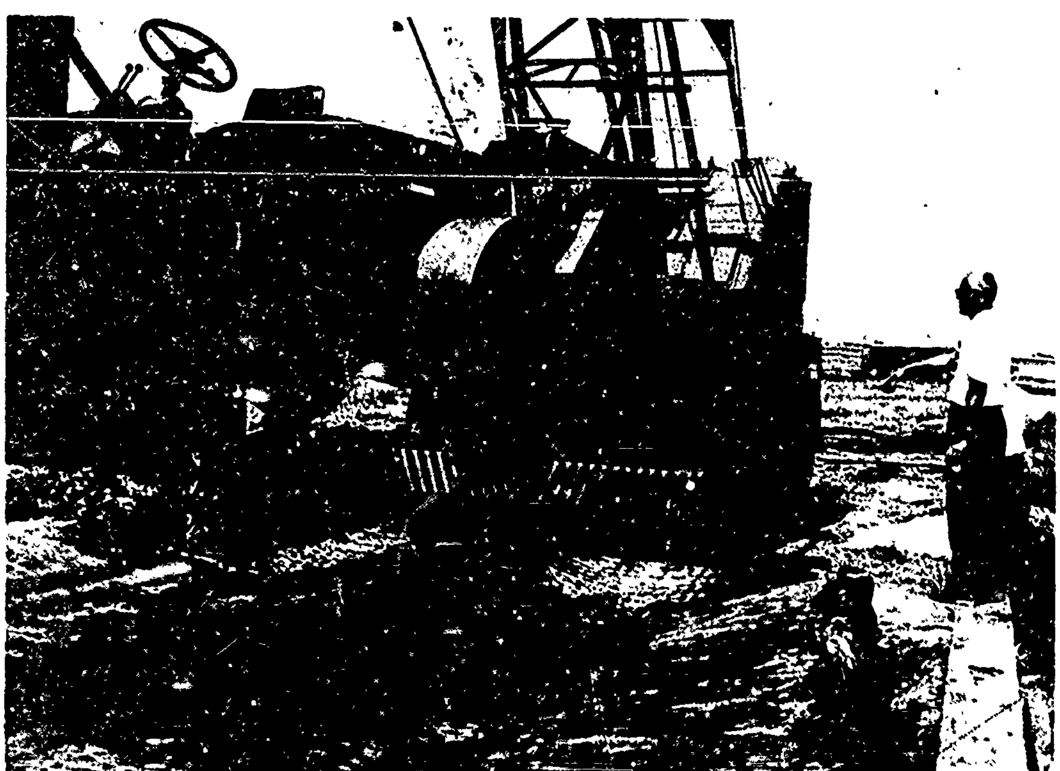


Figure 21. Views of Construction and Testing of Simulated C-130 Airplane - Pad 4 on Soil 2 (Clay) in the Soil Trench

TABLE XI SIMULATED C-130 AIRPLANE ROLLING WHEEL TEST CONDITIONS AND RESULTS

Soil Base	Pad No. (a)(c)	Section No.	Pad Density (lbs/ft^2)	Number of Layers of Woven Glass	Percent Spray Glass	Resin and Spray Glass System Used	Rolling Wheel Test Results (b)
Sand	1	1	2.15	2	9.8	Separate	After 52 passes with the loaded crane a few surface cracks had developed, and the pad was deflected about 10 inches in ruts (peak to peak).
Sand	1	2	2.75	2	17.4	Combined	After 52 passes with the loaded crane a few surface cracks had developed, and the pad was deflected about 2 inches in ruts (peak to peak).
Sand	2	1	3.08	2	11.8	Combined	After 30 passes with the loaded crane a crack developed 8 inches long, partly through. After 52 passes there was a 2.5 foot crack through the pad. The pad was deflected about 8 inches in ruts (peak to peak).
Sand	2	2	3.24	3	11.4	Combined	After 52 passes with the loaded crane there were no cracks. Ruts were about 6 inches deep (peak to peak).
Clay	3		4.86	4	11.5	Combined	After 12 passes with the loaded crane there were 2 small surface cracks, and ruts were about 15 inches deep (peak to peak).

TABLE XI SIMULATED C-130 AIRPLANE ROLLING WHEEL TEST CONDITIONS AND RESULTS (Continued)

Soil Base	Pad No.	Section No.	Pad Density (lbs/ft^2)	Number of Layers of Woven Glass	Percent Spray Glass	Resin and Spray Glass System Used	Rolling Wheel Test Results
Clay[(d)]	4	1	3.84	3	11	Combined	After 6 passes with the loaded crane ruts were about 10 inches deep (peak to peak).
Clay[(d)]	4	2	2.75	2	13	Combined	After 6 passes with the loaded crane ruts were about 12 inches deep (peak to peak).

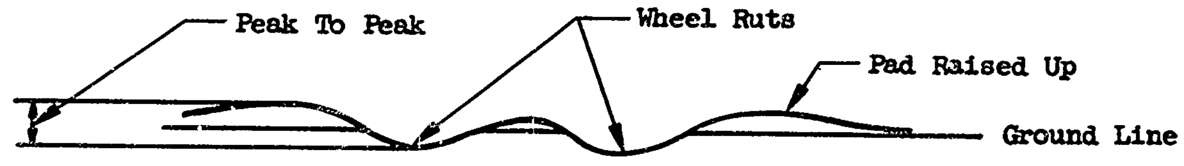
Note:

(a) For pad numbers refer to Figure 17, page 38.

(b) Test vehicle data are presented in Table X, page 39.

(c) All of these pads were rolled using hand rollers, to improve glass wetting and obtain a higher spray glass content.

(d) This pad was constructed over 6M PSP.



Sketch of Typical Pad Ruts Caused By The Loaded Crane

SECTION V

EQUIPMENT

A. DESCRIPTION OF APPLICATION EQUIPMENT

The application equipment used for this program was developed under contract AF33(615)-3068, for preparation of quick-curing resin remote VTOL aircraft landing sites. This equipment utilized a three-quarter ton truck as the prime mover, with a power take-off to drive an air compressor and two resin pumping systems. These two separate resin systems were each capable of producing variable catalized resin flow rates up to 7.5 gallons per minute. During operation of the equipment a mixture of catalyst and air was injected into the resin at the output nozzle section of a hand-held resin pole gun on each system. These pole guns were connected through long hoses to the resin and catalyst output connections on the truck. Flowmeters were provided on the truck to monitor both the resin and catalyst system outputs. Four 400-gallon tank trailers were provided for transport and supply of resin at the construction site. A trailer-mounted resin pumping unit was also provided to transfer resin from 55 gallon drums to the tank trailers. Four air operated mixers were included to mix in resin addatives in the drums or tank trailers.

In addition, continuous filament glass roving was sprayed through a plastic hose equipped with a glass gun, during construction operation. Air flow provided the motive force to spray out the glass. The glass gun contained an on/off lever-operated valve - which was used to start and stop the glass flow, and to cut off the glass strands at shutoff. Other glass equipment included two manually operated woven roving glass fabric dispensers used to transport and roll out single rolls of glass fabric at the construction site. Other miscellaneous equipment was provided and is listed in the appendix.

B. MODIFICATION, CHECKOUT, AND DEMONSTRATION

In preparation for SEA operations, the application equipment was modified and checked out as follows:

1. Automatic air filter water trap drains were installed on the truck.

2. A complete new set of resin and catalyst hoses was fabricated.

3. Fork lift provisions and tie down rings were added to the portable resin pumping unit.

4. All application equipment was cleaned, serviced, and checked out, as required.

The equipment was demonstrated at LTV during the SEA team training program.

C. EQUIPMENT, PARTS, AND SUPPLIES SENT TO SOUTHEAST ASIA

The necessary equipment, parts, and supplies were sent to SEA to support the program. Included with the equipment were two Lightweight Expandable Shelters which were designed and developed by the University of Cincinnati under Air Force Contract Number AF33(615)-1285. These shelters were provided by the Air Force Aero Propulsion Laboratory, Research and Technology Division, Wright-Patterson Air Force Base, Ohio, and were used for storage of the MEK peroxide and various tools, small equipment, and supplies. Four air-conditioning units were provided for these shelters to maintain the MEK peroxide stored in them at safe temperatures. Items shipped to SEA are listed in the appendix.

D. EQUIPMENT MANUAL

An equipment manual, LTV Number 2-51300/6R-50356, dated 15 September 1966, Operation and Maintenance Instructions - Rapid Site Application Equipment For Preparing Quick Cure Resin Test Sites, Volumes I and II, was provided. The manual presents a description of the application equipment, site construction methods, equipment maintenance details, and includes vendor data on the major application equipment items such as flowmeters, the air compressor, and the Dodge truck.

SECTION VI

AIR FORCE PERSONNEL TRAINING IN SOUTHEAST ASIA

The procedures used in training the Air Force team in SEA were the same as those used to train the LTV team, which are presented in Section IV, page 27. However, the actual site construction phase was on a much larger scale, and included Air Force participation in construction of all the various sites fabricated there. On-the-job training of this type necessarily slows down the construction operations; however, thorough training of the Air Force personnel was considered essential and necessary. Therefore, maximum utilization was made of the Air Force personnel in construction of the test sites. The Air Force team was completely responsible for organizing, directing, and constructing Pad Number 3 of the Cargo Storage Site. Upon completion of the SEA sites, the Air Force team was well trained in all phases of the operation and ready to take over the application equipment to construct additional sites.

SECTION VII

CONSTRUCTION OF TEST SITES IN SOUTHEAST ASIA

A. ADVANCE TRIP

In preparation for site construction operations, an advance trip was conducted jointly with Air Force (APFG) project engineers, to Southeast Asia, to evaluate soil and operating conditions, and to determine personnel and operational support requirements. The AFSC Sea Liaison Office and the Civil Engineering Directorate at Seventh Air Force Headquarters, Tan Son Nhut Air Field in Saigon were visited to discuss the proposed program of preparing quick-cure resin test sites in Southeast Asia.

Discussions were held at the Base Civil Engineering Office at the proposed location to review the planned program. Several change items were discussed, and a trip was made to the area where the sites were to be prepared. The changes were discussed with the AFSC Liaison Office, and their concurrence was obtained. The preliminary trip was considered valuable in that the weather and soil conditions were then well known, the living and working conditions were relayed to the team, and the program needed in SEA was well defined.

B. SITE LOCATIONS

All sites were prepared over sand, within the confines of established military reservations.

C. SOIL STABILIZATION MATERIAL TESTING

Prior to arrival of the resin in SEA, a Latex base soil stabilization material (Soil Guard) was tested. Soil Guard was mixed in one of the resin trailers in the ratio of two barrels of Soil Guard to five barrels of water. The mixture was applied by pumping through a spray bar with the resin transfer pump. See Figure 22, page 52, for views of the material application and results. Although only a month was available for evaluating the material, it was apparent that it would exhibit only limited effectiveness. In this respect its performance was similar to the other presently available dust palliatives. A quantitative comparison to other materials could not be made from this test. Voids were encountered in the material coverage which would, of course, affect overall performance. This was a function of application techniques as well as the material. Soil Guard will perform as an effective dust pallative in non-traffic areas on sand for a limited period of time.

D. AMMUNITION REVETMENT SITE

Upon receipt of the resin, site construction began with an ammunition revetment site. Special ladders and platforms were constructed and used for spraying operations on the soft, steep sand banks. The ladders were made of 1 1/4- by 10-inch lumber with 2- by 4-inch cross piece steps spaced eighteen inches apart. These ladders were used to traverse the steep sand slopes

MATERIAL APPLICATION

BROKEN SOIL STABILIZATION MATERIAL CRUST

Figure 22. Views of Latex Base Soil Stabilization Material Application and Results

of the revetment. The platforms, which were made for horizontal spraying operations, were constructed of 3/4-inch plywood in an L shape - to form a level walking base eighteen inches wide. These platforms were used for horizontal spraying (along the length of the revetment) on areas covered with resin only, and resin and spray glass.

Preparations for site construction included hand clearing of brush, roots, and debris from the surface to be sprayed. Hand raking was accomplished, as required, in preparation for spraying. In areas along the revetment slope where the sand was dry, footprints did not form. Preparations for woven glass coverage areas included positioning rolls of woven glass along the top of the revetment.

In laying out the woven glass on the slopes, two men held the glass roll at the top of the revetment, using the spindle from the woven glass dispenser, and the glass was pulled off the roll and down the slope. Next the woven glass was positioned for spraying and cut off the roll. Each successive strip of woven glass was overlapped approximately two inches onto the previously sprayed strip.

Figure 23, page 54, shows views of the ammunition revetment site construction. Table XII, page 56, presents material coverage data for this site. Three types of coverage were used for this site (resin only, resin with spray glass, and resin with woven glass). Resin with spray glass and resin with woven glass were very satisfactory. The resin only area was not considered satisfactory due to cracks that developed from the sand shifting, and was subsequently recovered with resin and woven glass. Also, some areas along the bottom of the revetment required reinforcement with woven glass, spray glass, and resin due to vehicles running up on them. The revetment reinforcement material coverage data is presented in Table XIII, page 57. Figure 24, page 59, shows a view inside the ammunition revetment along one side after completion of the lower edge reinforcement.

E. CARGO STORAGE SITE

Next a cargo storage site was constructed adjacent to a C-130 aircraft parking apron made of pierced steel planking (PSP). Figure 25, page 60, presents views of the site construction. Three different test pad thicknesses were fabricated, as follows:

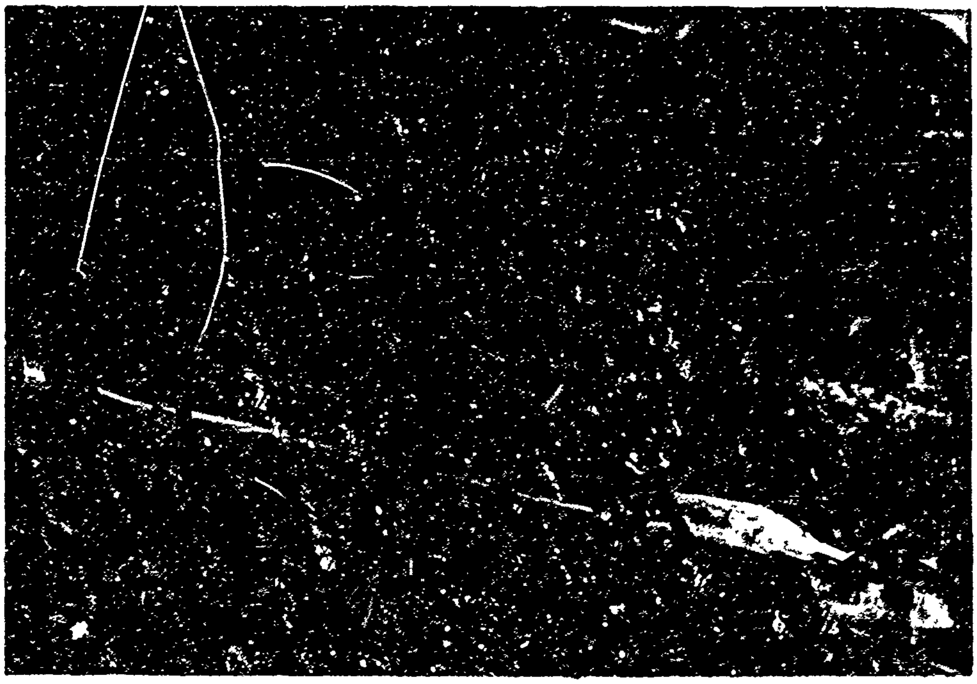
1. Pad 1 - nominal six pounds per square foot

2. Pad 2 - nominal four pounds per square foot

3. Pad 3 - nominal two pounds per square foot

Material coverage data are presented in Table XIV, page 62.

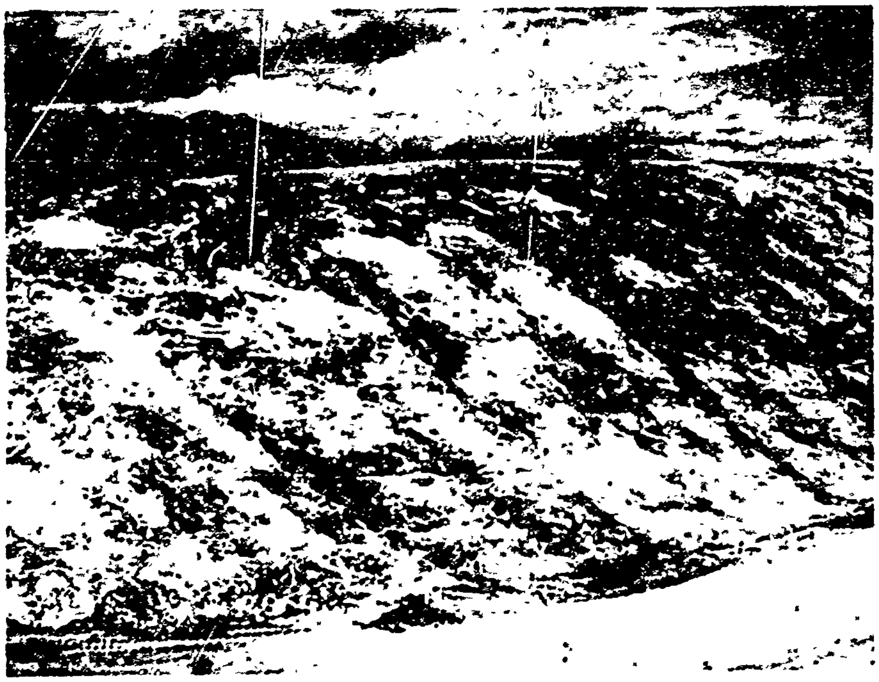
Pad construction was accomplished by rolling out a layer of woven roving glass fabric with the woven glass dispenser, and spraying the fabric with gun roving glass and resin. Successive layers were applied to obtain the desired pad thickness. Each layer represented approximately one pound per square foot of pad.



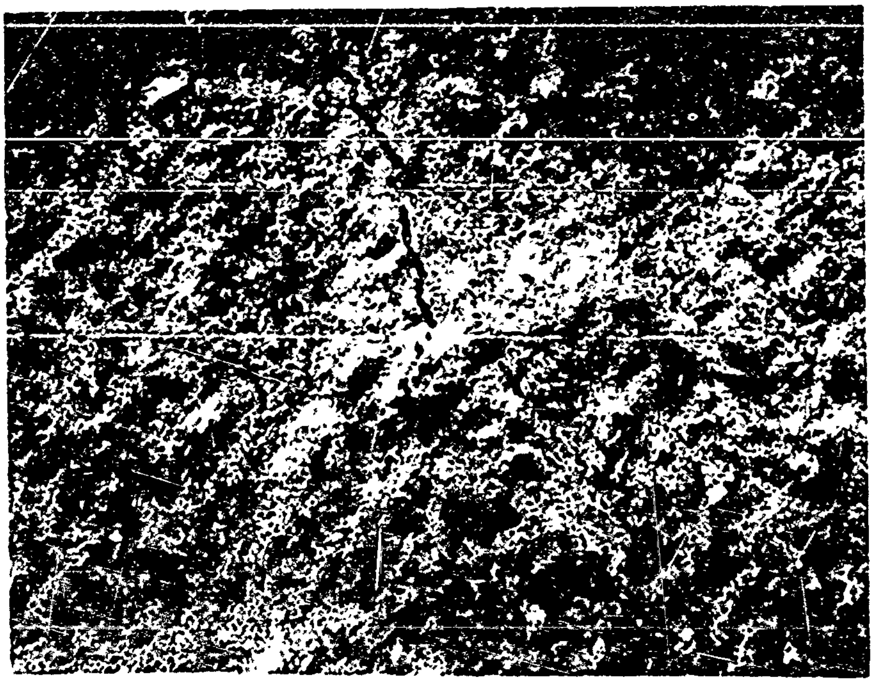
WOVEN ROVING AND RESIN COVERAGE

GUN ROVING AND RESIN COVERAGE

Figure 23. Views of Sand Ammunition Revetment Site Construction (Sheet 1)



COMPLETED GUN ROVING AND RESIN AREA



CRACK DUE TO SAND SHIFTING IN RESIN-ONLY AREA

Figure 23 Views of Sand Ammunition Revetment Site Construction (Sheet 2)

TABLE XII AMMUNITION REVETMENT COVERAGE

Area	Materials Used (lbs) Resin (a)	Woven Glass (b)	Spray Glass (c)	Total Wt. (lbs)	Area Covered (ft^2)	lbs/ft^2 Average	Percent Glass	Spraying Time
1	6,270	2,062	None	8,332	10,620	0.784	24	8 days
2	3,140	None	174	3,314	1,308	2.55	5	
3	10,120	None	None	10,120	11,120	0.91	-	
4	9,930	None	550	10,480	6,875	1.53	5.3	
5	8,780	None	610	9,390	6,000	1.56	6.5	
6	6,900	1,920	None	8,820	9,815	0.90	21.8	
7	1,500	None	87	1,587	1,800 (Est)	0.88	5.5	
8	8,060	2,760	None	10,820	14,100	0.77	25.2	
TOTALS	54,700	6,742	1,418	62,863	61,638			8 days

Notes:

(a) Resin weight figured at 10 lbs/gal.

(b) Woven glass figured at 1.5 lbs/yd^2, or 1.166 lbs/linear ft

(c) Spray glass figured at 29 lbs/roll, net

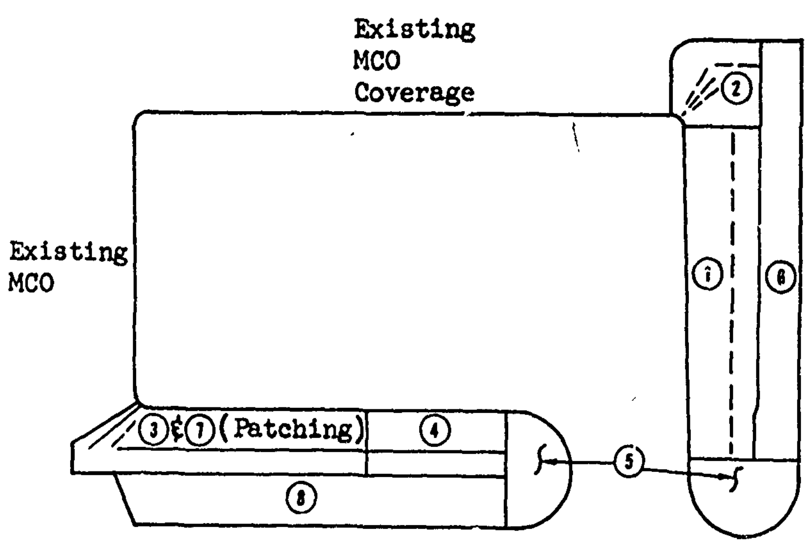
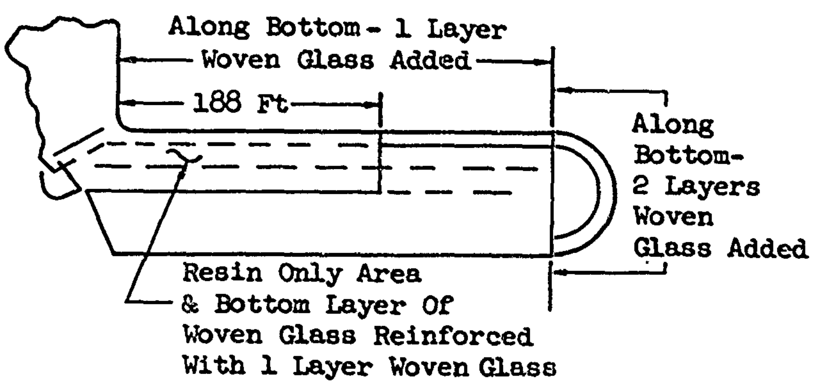
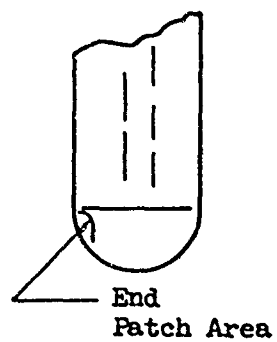


TABLE XIII AMMUNITION REVETMENT REINFORCEMENT

Coverage Area	Materials Used (lbs) Resin	Woven Glass	Spray Glass	Total Weight (lbs)	Area Covered (ft^2)	lbs/ft^2 Average	Percent Glass	Spraying Time (hours)	Hours At Site
Single layer of woven glass along bottom of revetment	2,950	236	362	3,548	2,100	1.69	16.85	.87	4.5
Double layer of woven glass at end along bottom of revetment	2,270	124	278	2,672	800	3.44	15.00		
Other woven glass coverage of resin only area	6,940	2,320	-	9,260	10,290	0.90	25	1.15	4
End patch (one system only)	70	12	6	88	66	1.35	22	.20	.25
TOTALS	12,230	2,692	646	15,568	13,256				





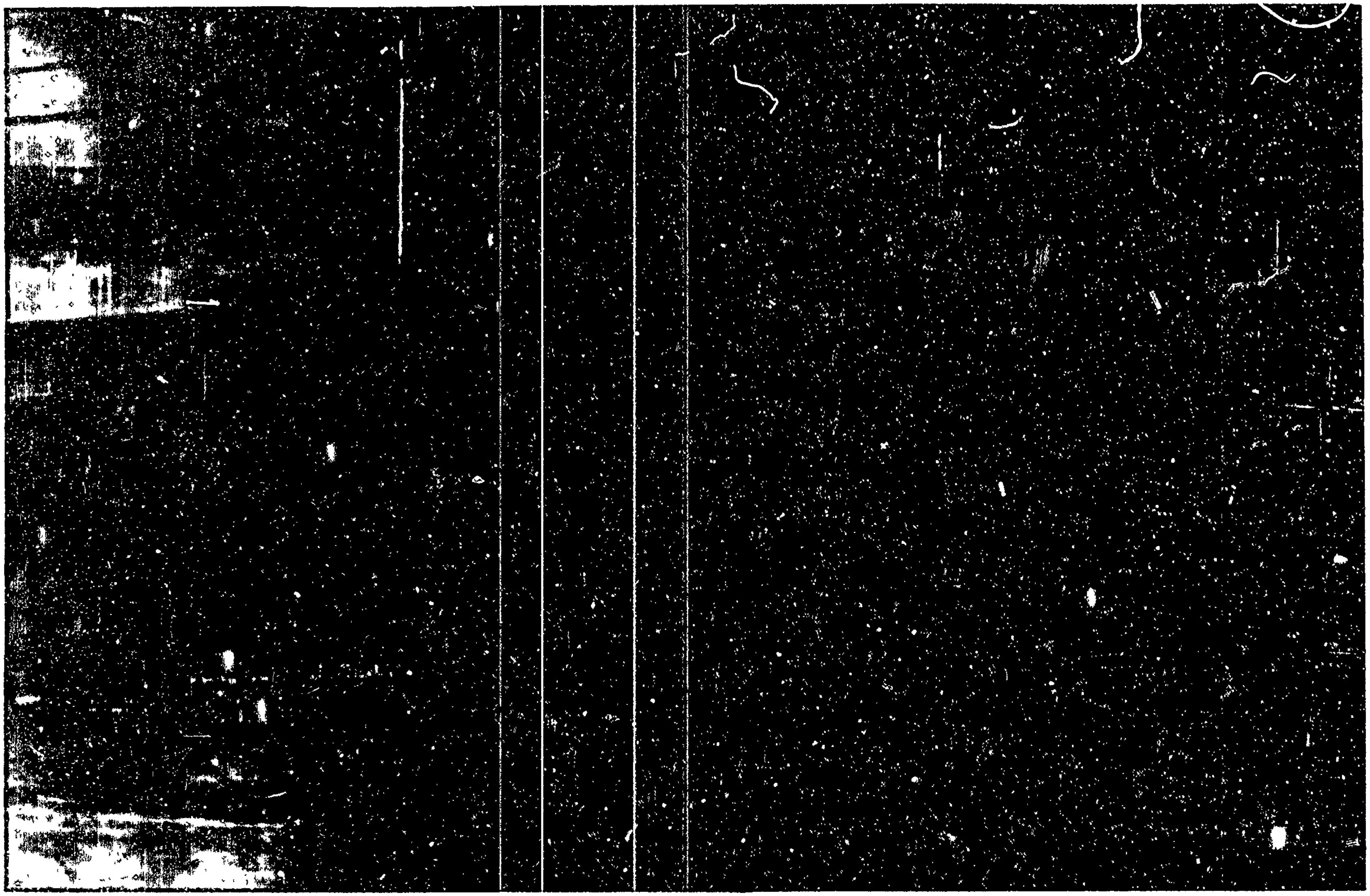
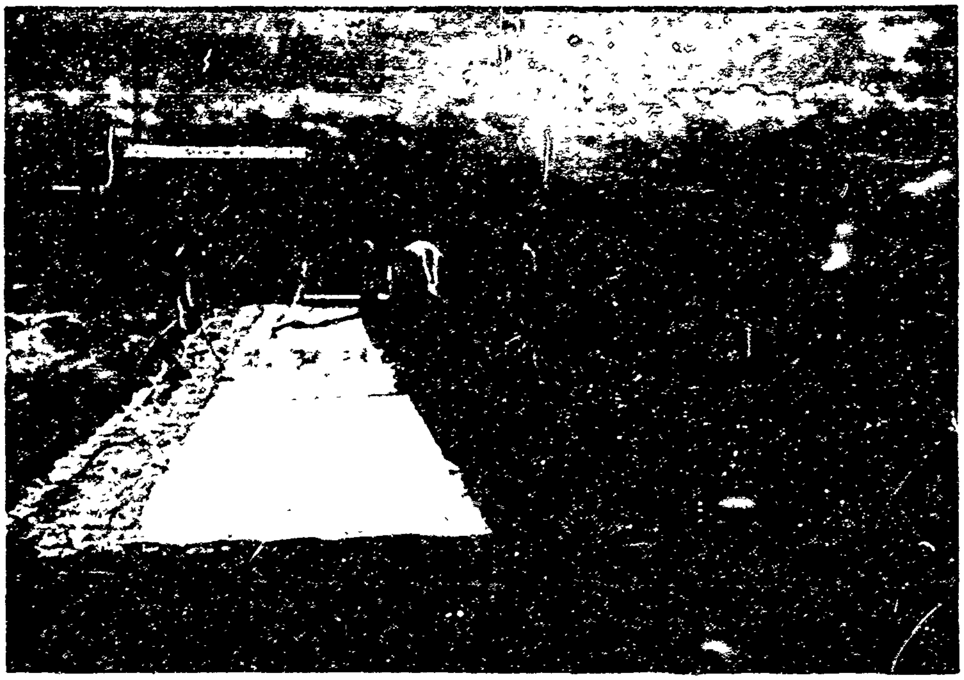
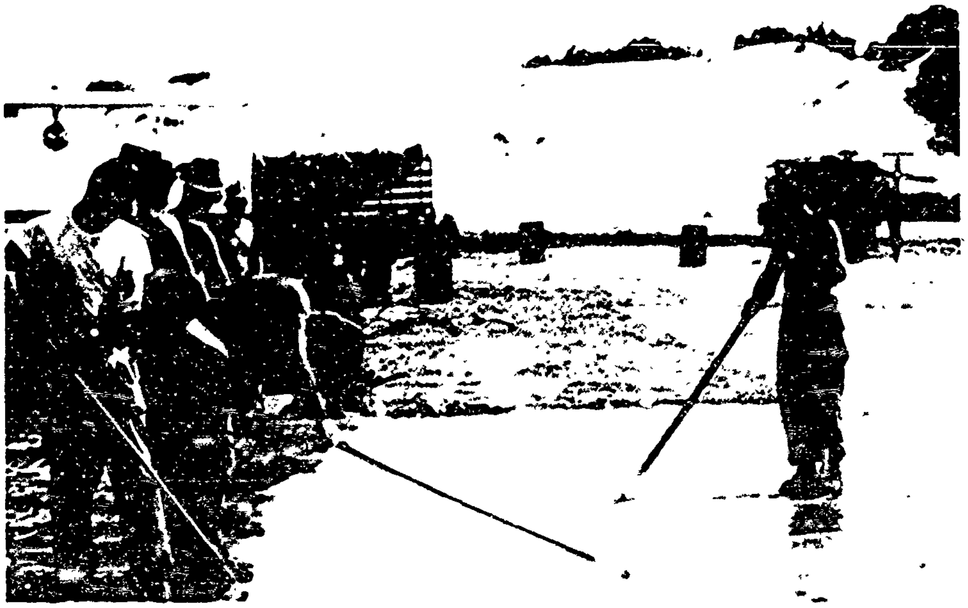


Figure 24. View Inside Ammunition Revetment After Completion of Lower Edge Reinforcement

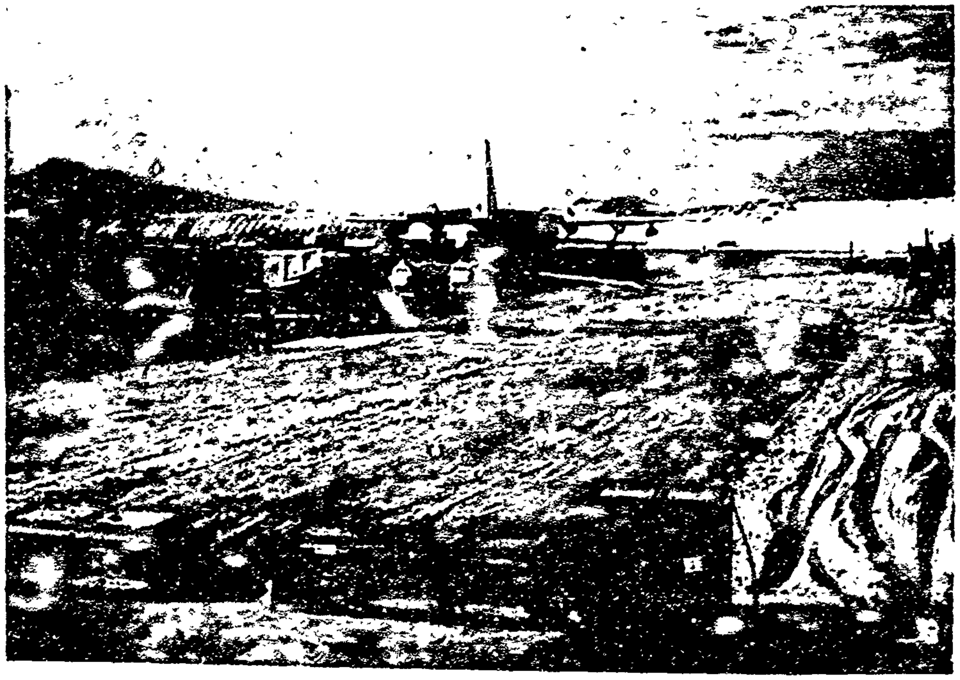


START OF CONSTRUCTION

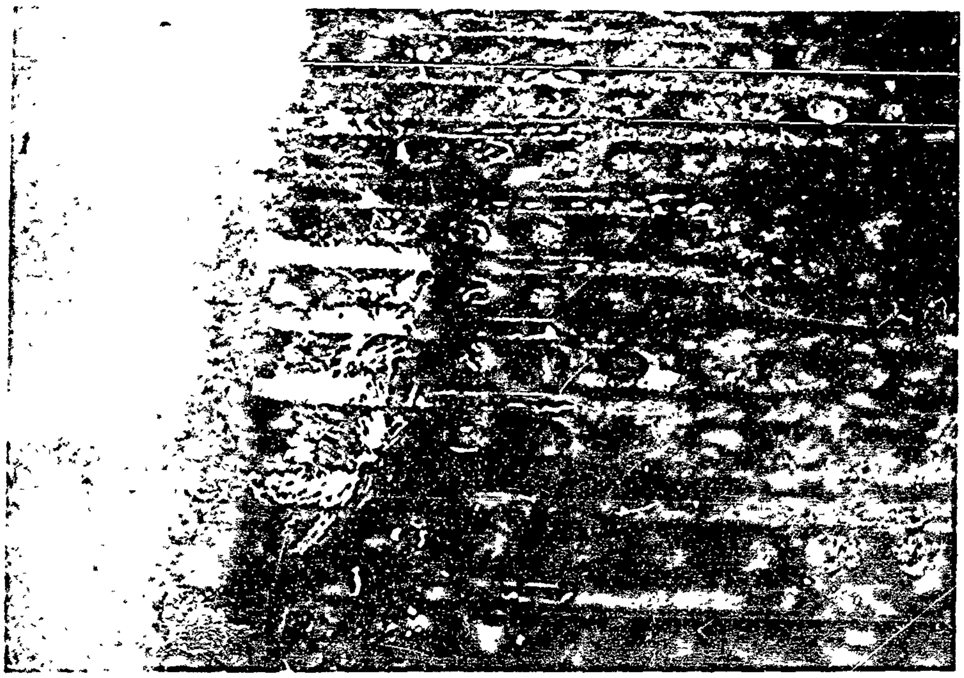


UNDER CONSTRUCTION

Figure 25. Views of Cargo Storage Site Construction
(Sheet 1)



PARTIALLY CONSTRUCTED



TYPICAL OVERLAP ONTO PSP

Figure 25. Views of Cargo Storage Site Construction (Sheet 2)

TABLE XIV CARGO STORAGE AREA COVERAGE

Pad No. (a)	Materials Used (lbs) Resin (b)	Woven Glass (c)	Spray Glass (d)	Total Weight (lbs)	Area Covered (ft^2)	Density lbs/ft^2 (Actual)	Percent Glass	Spraying Time
Pad 1	38,670	6,250	5,880	50,800	6,396	8	24.0	10.5 days
Pad 2	26,090	4,500	3,600	34,190	6,810	5	23.75	
Pad 3	15,660	2,625	2,130	20,415	7,260	2.8	23.2	
TOTALS	80,420	13,375	11,610	105,405	20,466			10.5 days

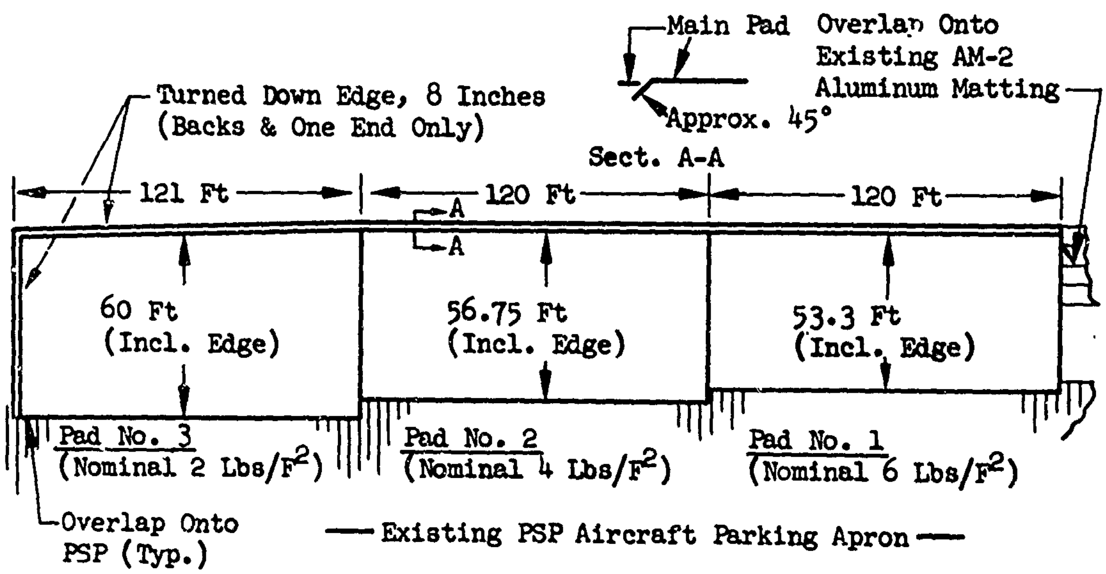
Note:

(a) Pad 1 - 6 lbs/ft^2 nominal. Pad 2 - 4 lbs/ft^2 nominal. Pad 3 - 2 lbs/ft^2 nominal.

(b) Resin weight figured at 10 lbs/gal

(c) Woven glass figured at 1.5 lbs/yd^2, or 1.166 lbs/linear ft

(d) Spray glass figured at 30 lbs/roll, net



CARGO STORAGE AREA COVERAGE

For Pad 1 (a six-layer nominal six pounds per square foot pad) four layers were applied over the entire surface area first. A "shingle lap" type of construction was used, with each layer of woven glass overlap staggered in a distance of one fourth of the width of the glass fabric. Upon completion of the first four layers, two more layers were added to the pad. The "shingle type" construction was continued, using an overlap of half the woven glass fabric width, to complete the six layer pad. Partial woven glass widths (1/4, 1/2, and 3/4) were required at the start of, and finish of the pad.

Pad 2 (a four-layer nominal four pounds per square foot pad) was constructed like the first four layers of Pad 1.

Pad 3 (a two-layer nominal two pounds per square foot pad) was constructed like the last two layers of Pad 1.

The combined resin and glass spray system (developed during LTV SEA team training-operated by one man) was used during the initial part of the site construction. Later, the two-man separate resin and spray glass system was used. Glass was sprayed from the large glass pot, feeding simultaneously from two glass rolls. Small glass pots with a single glass roll were used to fill in, while the large glass pots were being serviced. The pad was rolled using hand rollers to aid in wetting the glass. Planned C-130 airplane rolling wheel testing of the Cargo Storage Site was not accomplished, due to non-availability of aircraft. The C-130E airplane test plans included starting with an unloaded aircraft weight of approximately 71,750 pounds, and building up to the maximum fully loaded condition of 155,000 pounds. For each load condition, progression was to be made from the thickest to the thinnest pad, and testing was to be discontinued if pad deflections became excessive, or there was any other cause for concern.

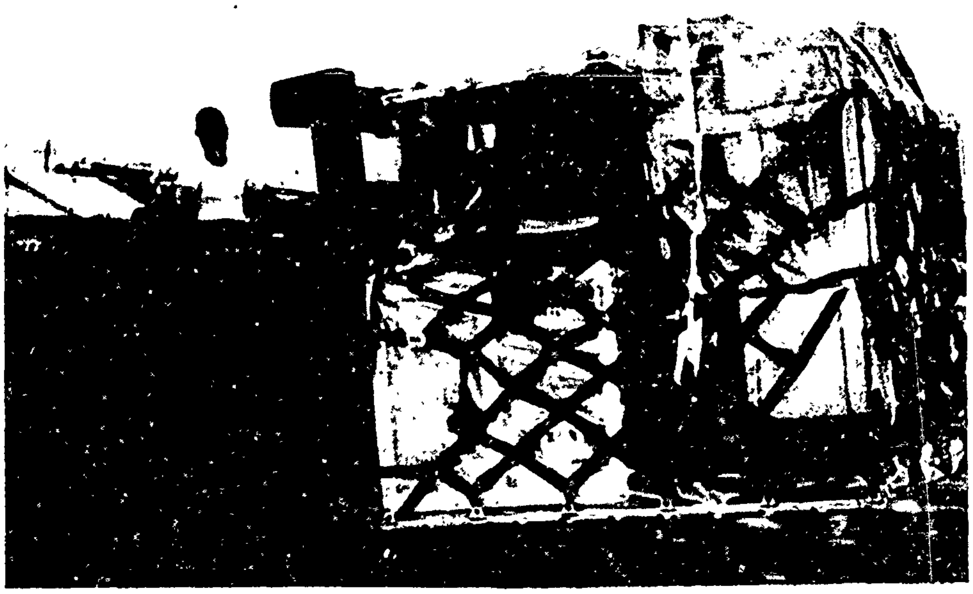
Other testing was accomplished, however, using loaded fork lifts, a large loaded fuel truck, and cargo pallets placed on two boards (static loading). Views of initial testing of the Cargo Storage Site are presented in Figure 26, page 64. Table XV, page 66, presents test conditions and results of this testing. Before departure from SEA (after two weeks of heavy use), this site was examined and found to be in excellent condition.

F. QUONSET HUT SITE

Rapid Site material was applied to a joint seam (on a large Quonset hut type building) that was suspected of leaking. This seam section, at the top of the building, was about 35 feet long. See Figure 27, page 67, for views of the Quonset hut site operations.

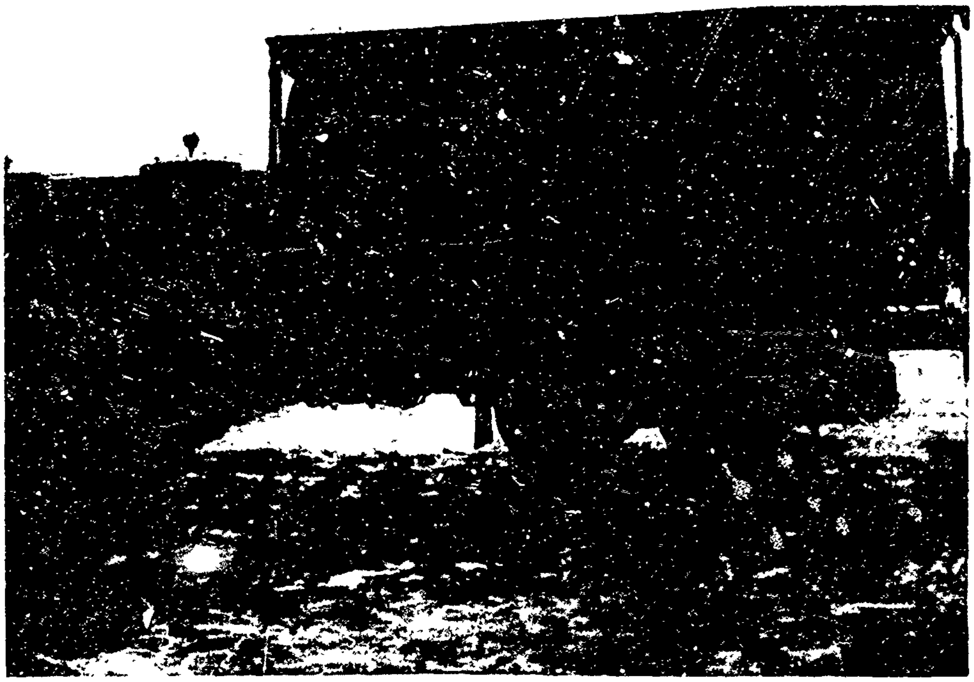
The first two-foot section of the seam was sealed using woven roving glass fabric (24 ounces per square yard) saturated with catalyzed Hetron 24689 resin, promoted with 0.75 percent cobalt naphthenate. This method proved to be impractical, as much difficulty was encountered in maintaining the fabric in the corrugations of the metal roofing. The remainder of the seam was sealed by trowelling a mixture of two to three percent random

27,270 POUND FORKLIFT



25,723 POUND FORKLIFT

Figure 26. Views of Cargo Storage Site Testing
(Sheet 1)



FUEL TRUCK ON PAD NO. 2

STORAGE OF CARGO

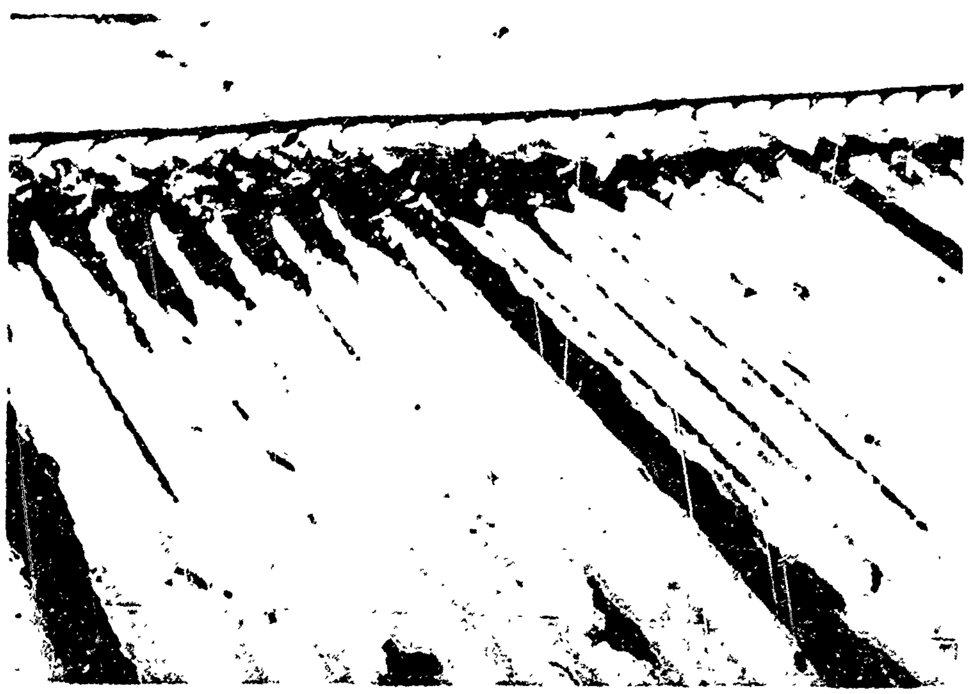
Figure 26. Views of Cargo Storage Site Testing (Sheet 2)

TABLE XV CARGO STORAGE AREA TESTING

Date	Pad No(a)	Type of Loading	Weight (lbs)	Tire Data		Model	Pallet Load Contact Area
				Frnt	Rear		
9/16/66	2	Fork Lift with Pallet	22,370 3,353 25,723	(2) 32-21 16 ply 85 psi (contact area 132 in^2 each)	(2) 15-22.5 ply, 85 psi (contact area 102 in^2 each)	Hyster P100A-AF-48	2 ft^2 (two 3 ft 4 x 4 boards)
9/16/66	2	Fork Lift with Pallet	23,500 3,770 27,270	(2) 8.25-15 12 ply 90 psi (contact area 84 in^2 each)	(2) 7.50-15, 10 ply, 70 psi (contact area 84 in^2 each)	Hyster	2 ft^2 (two 3 ft 4 x 4 boards)
9/16/66	1 and 2	Fuel Truck with Fuel	62,750 19,500 82,250	60 psi	60 psi		
9/17/66	3	Fuel Truck with Fuel	62,750 30,000 92,750	60 psi	60 psi		
9/17/66	2	Pallet	7,885	-	-	-	2.6 ft^2 (two 5 ft 4 x 4 boards)

Note:

(a) Pad 1 - 6 lbs/ft^2 nominal. Pad 2 - 4 lbs/ft^2 nominal. Pad 3 - 2 lbs/ft^2 nominal. Refer to Table XVI, Page 69, for a sketch of the area.



SEALED JOINT

SEALING OPERATION

Figure 27. Views of Quonset Hut Site Operations

chopped fiber glass and resin. This method produced satisfactory looking results, but required two men 2.5 hours to complete. The principal problem was the difficulty encountered in maneuvering on the curved metal roof.

Examination of the building after subsequent rainstorms revealed that the test seam was apparently not leaking; however, there was still considerable leakage in the building. Since special maneuvering equipment (that was not available) would be required to adequately continue the joint sealing effort, work on this task was discontinued.

G. ENGINE RUNUP AREA SITES

Site construction was continued with the stabilization of two jet engine runup stands - to prevent soil erosion caused by the jet blast turbulence. This erosion was undermining the concrete support base and causing the concrete to crack. The application equipment was set up to spray with both systems. Preparations for spraying included removing a row of sand bags along the outer edge of the area to be covered. A ditch about six inches deep was dug with shovels to form an outer edge restraint. Spray glass and resin coverage was applied first, followed by a layer of woven glass and then additional spray glass and resin. A few inches of overlap onto the concrete were used to secure the inward edge. Overlapping into the trench secured the outer edge. At completion of spraying the dirt and sand bags that were previously removed along the trench were put back in place. Table XVI, page 69, presents coverage data for these sites. Figure 28, page 71, presents a sketch of engine runup area No. 1; engine runup area No. 2 is similar. Figure 29, page 72, presents views of these sites. Examination of these sites after jet blast operation, revealed that erosion was prevented in the coverage areas, and that these sites were entirely satisfactory.

H. METAL REVETMENT SITE

Another problem that was encountered was leakage of sand filled metal revetments during aircraft jet engine operation. A test section of metal revetment was selected for sealing with Rapid Site material. Six different material combinations were used to seal both horizontal and vertical seams. These material combinations are presented in Table XVII, page 74. Resin only was applied to a horizontal seam and was found to be too thin to effect a good seal. The resin only seam was resealed with the resin and Cab-O-Sil mixture. Each selected material combination was applied to selected horizontal and vertical seams, as shown in Figure 30, page 75. See Figure 31, page 76, for views of the metal revetment.

Prior to application of the material, the area to be sealed was cleaned with steel wool and scouring cleaner mixed with water except for the bottom horizontal seam (covered with combination 6) which was not cleaned before sealing. This was followed with a water rinse and wipe down with clean cloths.

Approximately four hours after completion of the sealing, jet blast tests were conducted. An F4C twin jet aircraft was located with its engine exhaust outlets about twenty-five feet from the revetment - pointed toward

TABLE XVI ENGINE RUNUP AREAS, SAND BAG EMPLACEMENT, PSP OVERSPRAY, AND ROADWAY COVERAGE

Coverage Area	Materials Used (lbs) Resin (a)	Woven Glass (b)	Spray Glass (c)	Total Weight (lbs)	Area Covered (ft^2)	lbs/ft^2 Average	Percent Glass	Spraying Time (hours)	Hours At Site
Engine Runup Area 1 (d)	1,530	117	60	1,707	625	2.73	10.4	.26	1.7
Engine Runup Area 2 (e)	1,520	100	80	1,700	520	3.26	10.6	.25	2
Sand Bag Emplacement Roof (f)	1,160	76	60	1,297	345	3.76	10.5	.387	2
Sand Bag Emplacement Walls (g)	500	-	-	500	460	1.08	0	.6	3.3
PSP Overspray (h)	11,450	820	585	12,855	4,180	3.08	10.9	1.9	8.6
Roadway (i)	3,480	765	510	4,755	990	4.87	26.4	1.16	8.5
TOTALS	19,640	1,878	1,295	22,814					

Notes:

(a) Resin weight figured at 10 lbs/gallon

(b) Woven glass figured at 1.5 lbs/yd^2

(c) Spray glass figured at 30 lbs/roll

(d) For engine runup area 1, per Figure 28, page 71

(e) For engine runup area 2 - similar to area 1.

(f) Sand bag emplacement roof only. (one system used)

(g) Sand bag emplacement walls only. (one system used)

(h) PSP coverage at fire station, per Figure 35, page 85

(i) Roadway coverage (one system used) per Figure 36, page 86

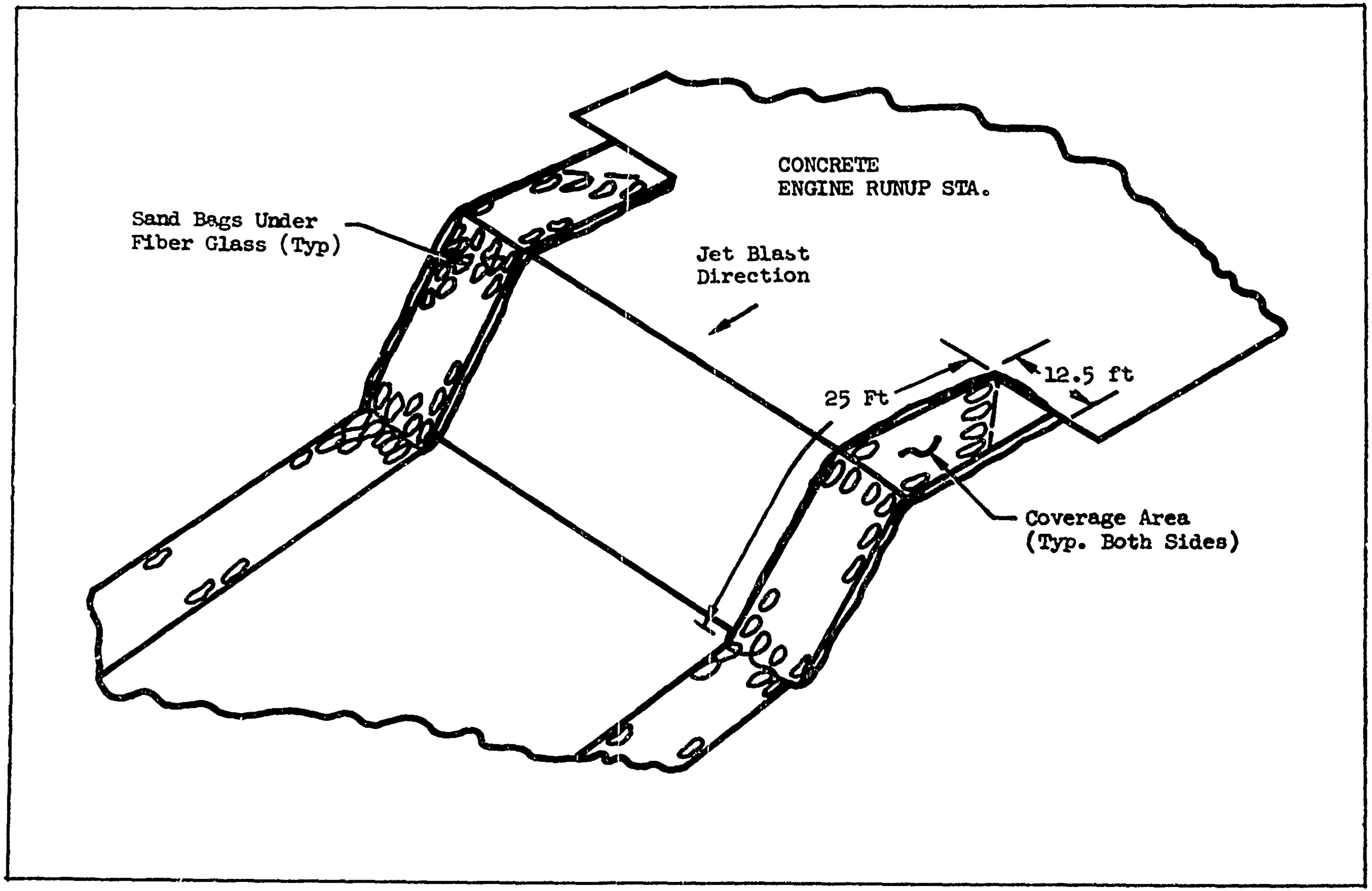


Figure 28. Engine Runup Area 1 Coverage

AREA NO.1 COVERAGE

SITE CONSTRUCTION

Figure 29. Views of Engine Runup Station Sites (Sheet 1)

AREA NO.2 SAND EROSION

AREA NO.2 COVERAGE

Figure 29. Views of Engine Runup Station Sites (Sheet 2)

TABLE XVII METAL REVETMENT MATERIAL COMBINATIONS

Material Combination Number	Material Combination
1	Resin only
2	Resin with six percent Cab-O-Sil
3	Sixty-five percent resin with 33 percent calcium carbonate (chalk) and 2 percent Cab-O-Sil.
4	Resin with five percent random chopped glass (one quarter inch maximum length) added.
5	Resin with spray glass roving.
6	Resin with woven roving glass fabric.

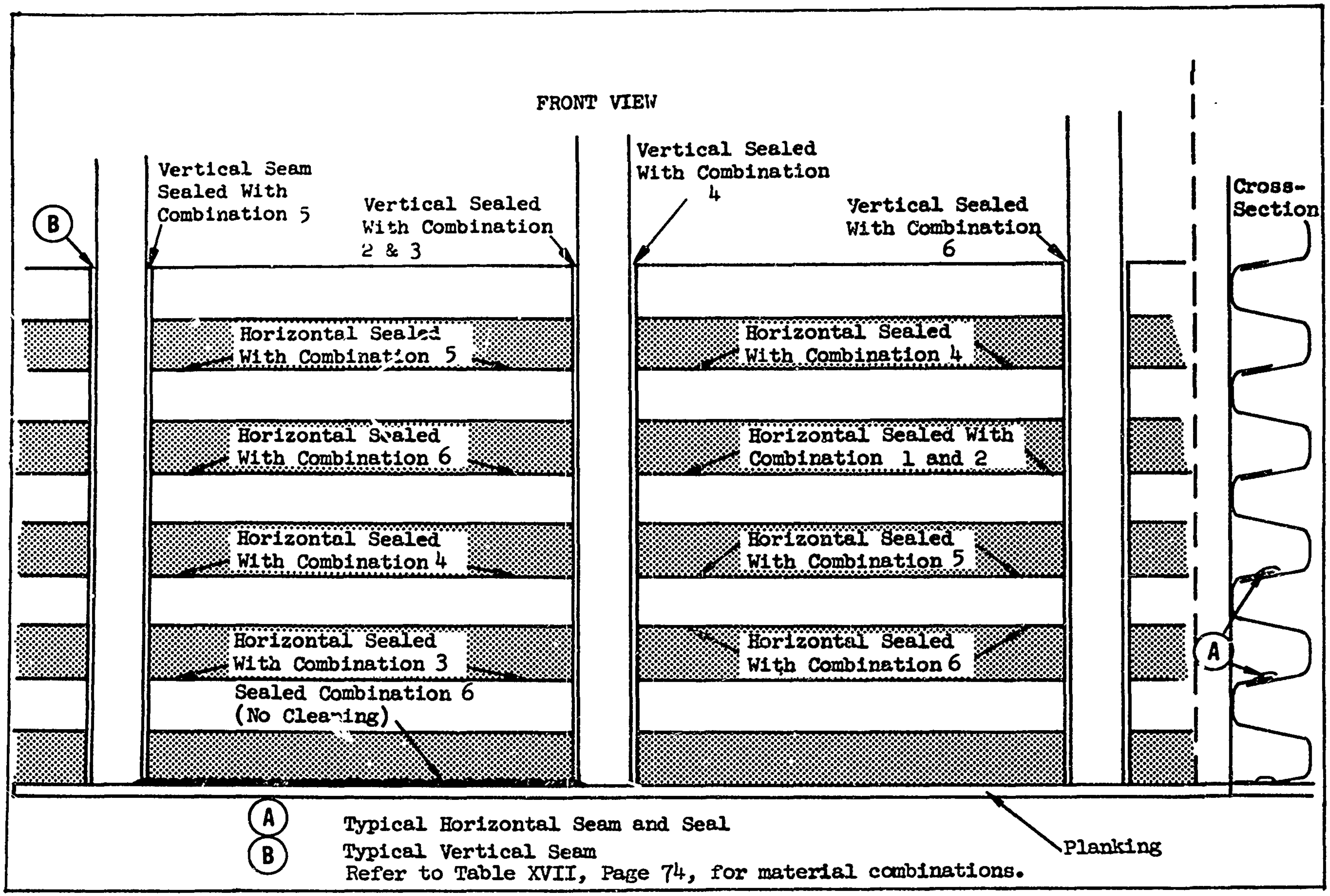
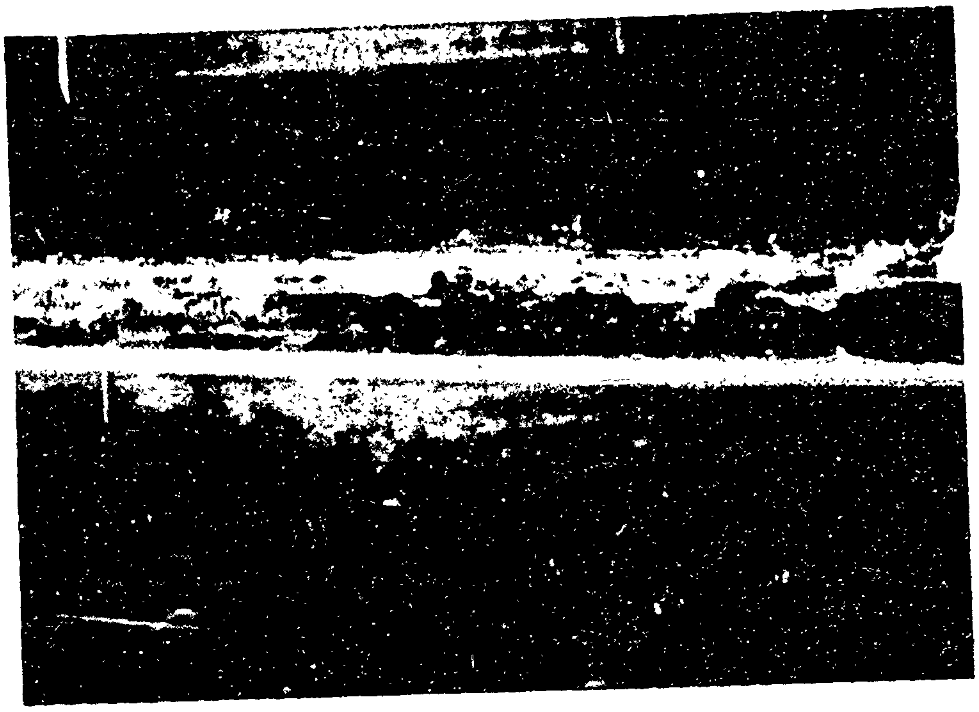
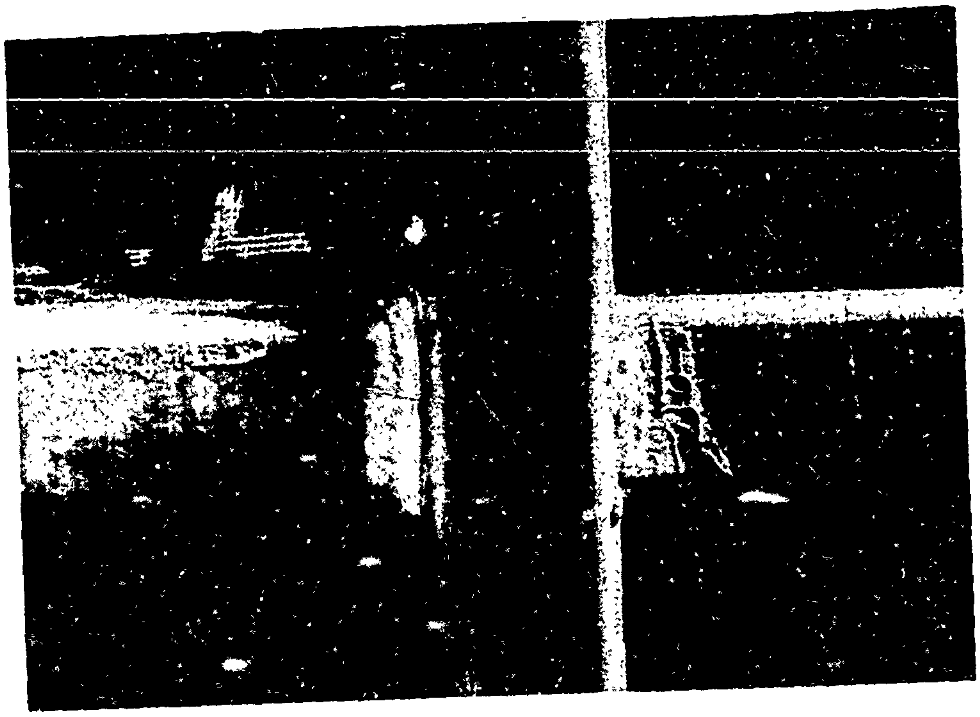


Figure 30. Metal Revetment Coverage Areas

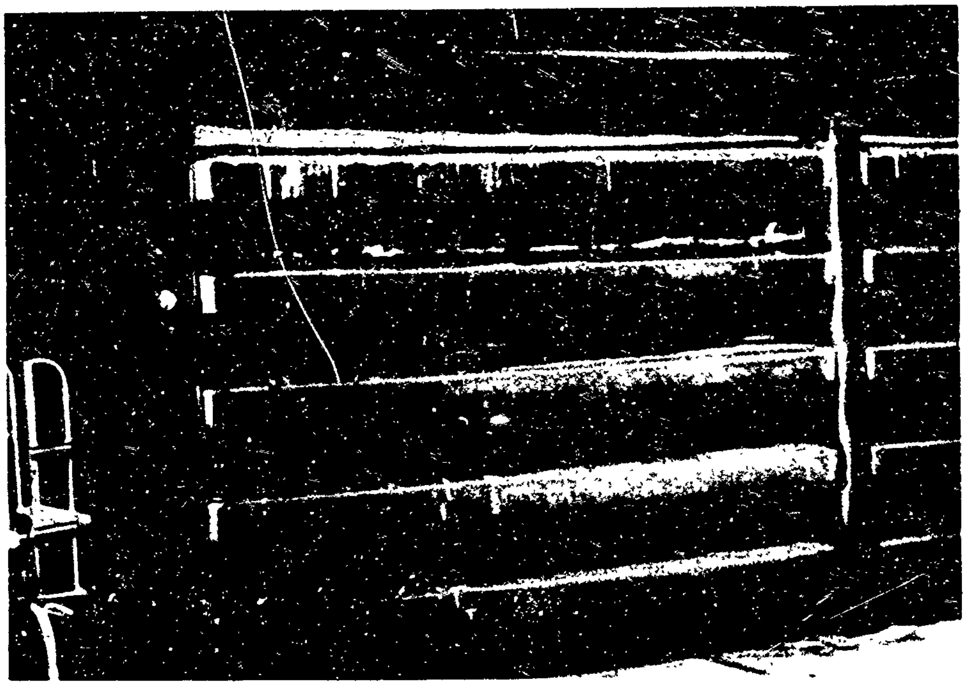


HORIZONTAL SEAM



VERTICAL SEAM

Figure 31. Views of Metal Revetment (Sheet 1)



TEST SECTION SEALED

PREPARATIONS FOR TESTING

Figure 31. Views of Metal Revetment (Sheet 2)

the sealed area. Both engines were operated simultaneously at eighty percent power for eight short, intermittent blasts of approximately five seconds each. During these tests no leakage of sand was observed from the sealed area; however, all seams immediately adjacent to the sealed area were observed to leak sand profusely. Examination of the sealed area after testing revealed that combination 4 had lost adhesion in several places along the horizontal seam. All other combinations appeared to be satisfactory, and showed no change except for a slight softening. Approximately three weeks later, the sealed area was examined again. Table XVIII, page 79, presents the results of this inspection. Although combination 5 performed well, it was very difficult to apply the woven fabric to the vertical seams, and it did not provide complete coverage due to the open weave construction.

The addition of fiber glass reinforcement to the resin tends to eliminate extensive cracking, and addition of small percentages of Cab-O-Sil to the resin decreases the resin flow, thereby making it easier to apply. Additional material combinations were tried in the temporary laboratory in SEA. The results of this testing indicate that the mixture most suitable for use was as follows:

1. 100 parts (by weight) promoted resin

2. 2 parts Cab-O-Sil

3. 2 parts chopped fiber glass (1/4-inch maximum length)

Additional tests were conducted at LTV to determine the adhesive qualities of the proposed sealing material. The results of these tests are presented in Table XIX, page 80.

I. SAND BAG EMPLACEMENT SITE

Next a sand bag emplacement was covered with Rapid Site material. Consideration was given to the type and extent of coverage to use. It was decided that the outer surfaces would be covered to prevent rotting of the sand bags and seal out water, and that the inside surfaces should not be covered - thereby allowing the sand bags to breathe. Only one spraying system was used for this test. The roof was covered with gun roving glass and resin, followed by one layer of glass woven fabric, which was covered with more gun roving glass and resin. The outside walls were sprayed with resin containing two percent Cab-O-Sil. The Cab-O-Sil filled resin was pumped directly out of a 55 gallon drum using the regular intake suction hose. Figures 32 and 33, pages 81 and 82, show views of the spraying operations and a sketch of the sand bag emplacement site. Table XVI, page 69, presents material coverage data for this site. Examination of the sand bag emplacement at completion of the program revealed that the site was in very good condition.

J. PIERCED STEEL PLANKING (PSP) OVERSPRAY SITE

A section of Pierced Steel Planking (PSP) between the fire station and the taxiway was sprayed with gun roving glass and resin - followed with one

TABLE XVIII RESULTS OF METAL REVETMENT INSPECTION
APPROXIMATELY THREE WEEKS AFTER CONSTRUCTION

Material Combination	Inspection Results
2	These seams were in good condition except for slight loss of adhesion on the horizontal seams and slight cracking on the vertical seams.
3	There was moderate loss of adhesion on the horizontal surfaces plus cracking and loss of adhesion on the vertical surfaces.
4	These seams were in good condition except for slight loss of adhesion on the vertical seams.
5	There was moderate loss of the horizontal surfaces and slight cracking on the vertical surfaces.
6	These seams were in good condition with no loss of adhesion, for both the precleaned, and uncleaned areas. (The area that was not cleaned before sealing was out of the most intense blast area and, therefore, was subjected to less severe testing.)

TABLE XIX ADHESION TEST RESULTS

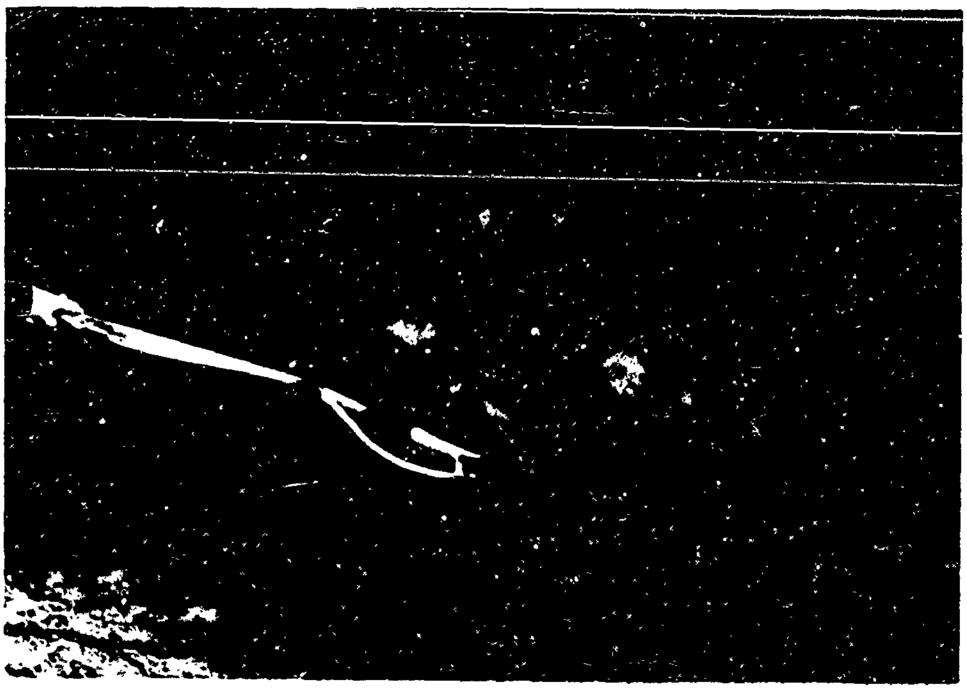
Material Composition	Specimen No.	Load (lbs)
24689 Resin with 5%-Chopped Glass(a)	1	450
	2	600
	3	400
	Average	480
24689 Resin with 2%-Cab-O-Sil and 2%-Chopped Glass(b)	1	850
	2	550
	3	550
	Average	650

Notes:

(a) Material combination 4, Table XVII., page 74 .

(b) The proposed mix (containing 2% Cab-O-Sil) shown here is compared with combination which was used on the metal revetment in SEA.

ROOF COVERING



SIDE WALL COVERING

Figure 32. Views of Sandbag Emplacement Covering

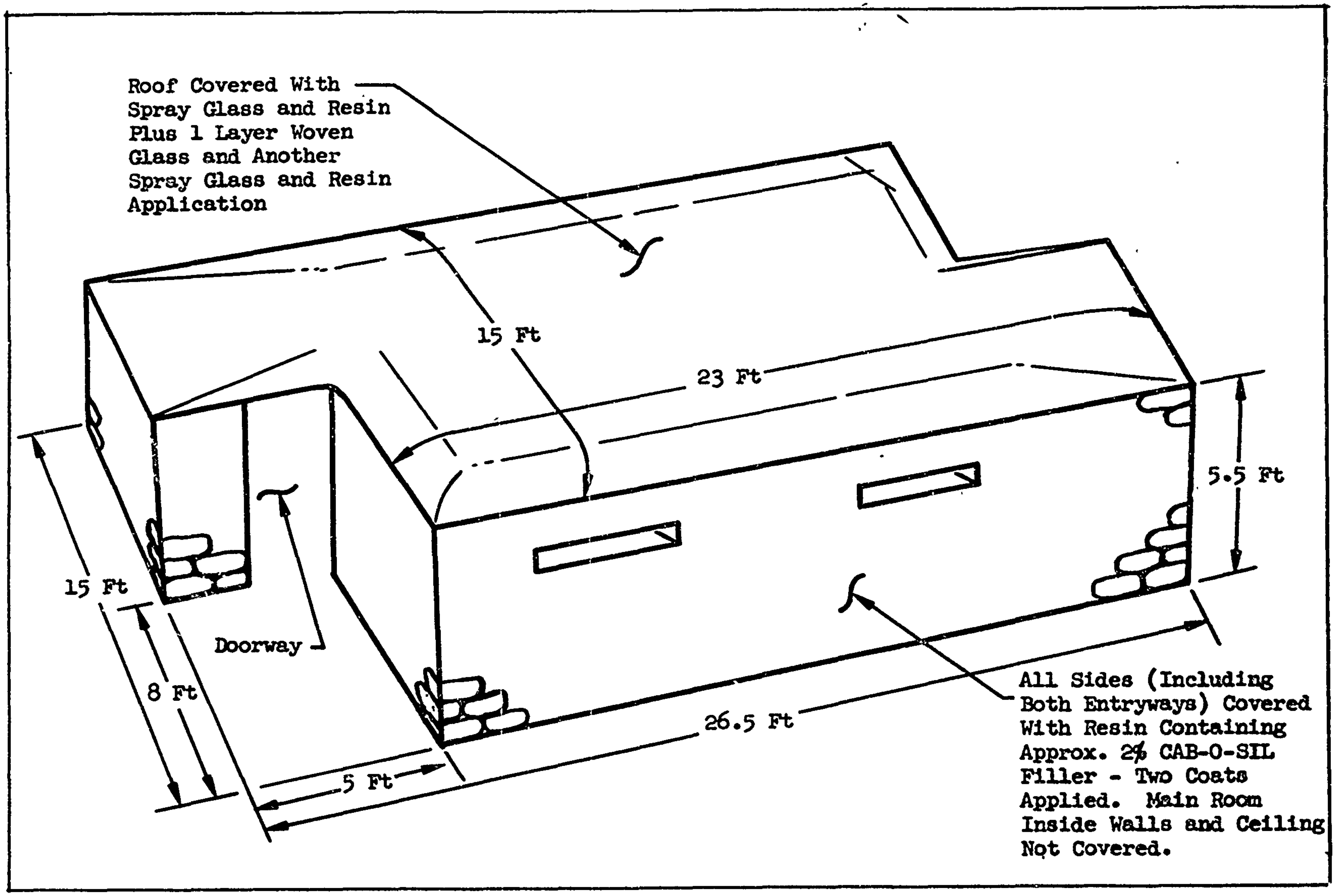


Figure 33. Sand Bag Emplacement Coverage

layer of woven glass, which was covered with more gun roving glass and resin. Moisture was a primary concern in construction of this site since there were low, wet areas which could not drain. Preparation for construction included filling in the low areas and the voids in the PSP with laterite. After spreading out the laterite on the PSP, excess material was removed with a grader, shovels, and brooms. Both spraying systems were used in construction of this site, and the woven glass was rolled out for spraying using the woven glass dispenser. Each successive layer of woven glass was overlapped onto the preceding layer approximately two inches. One low area was still slightly damp when sprayed. Figure 34, page 84, shows views of this site. Figure 35, page 85, presents a sketch of the site. Table XVI, page 69, presents material coverage data for this site. Subsequent inspection revealed that the pad had apparently separated from the PSP in the damp area, but was not considered detrimental to utilization of the area.

K. ROADWAY SITE

Next a section of roadway adjacent to the cargo storage site and the PSP C-130 airplane parking apron was covered with Rapid Site material. This roadway, being a heavy traffic area - carrying all the traffic unloading the C-130 airplanes - presented an opportunity for pad evaluation under very heavy use conditions. A sketch of the site is presented in Figure 36, page 86. Table XVI, page 69, presents material coverage data for this site. Subsequent inspection revealed no damage to the site after several days of use, even though the area where the pad was tied into aluminum planking received considerable flexing every time a heavy load ran off the pad onto the loose planking. This completed the program for the Air Force.

L. HELICOPTER SITE

The necessary equipment and materials were transported by C-130 airplane to an Army Base for construction of the last tw sites. A 120-foot square heliport (nominal two pounds per square foot) was fabricated as shown in Figure 37, page 87. This site was constructed on loose, sandy soil. Preparations for construction included hand clearing of brush stubbles and debris, and hand raking. After marking off the site perimeter with stakes and strands of continuous filament glass, a trench was dug approximately eight inches deep, along the first edge to be sprayed.

During construction of the site both spraying systems were used. Woven glass was laid out across the full width of the site and down into the edge trench, using the glass dispenser. Edge trench digging was continued as construction progressed to stay ahead of the spraying operations. An additional layer (including woven glass, spray glass, and resin) was added to reinforce the edge (approximately the first 40 inches) - making the total edge density a nominal three pounds per square foot. This edge restraint was fabricated to provide for anticipated ground vehicle traffic (fuel trucks, etc.) across the site edge and the surrounding sand. Edge restraints are not necessary for helicopter sites to prevent site lifting, due to the relatively low downwash pressures that are produced. See Figure 38, page 88, for views of the heliport site construction. Table XX, page 90, presents material coverage data for this site. A large H was painted at the

COMPLETED SITE

SITE JOINED TO ALUMINUM MAT RUNWAY

Figure 34. Views of Fire Station PSP Overspray Site

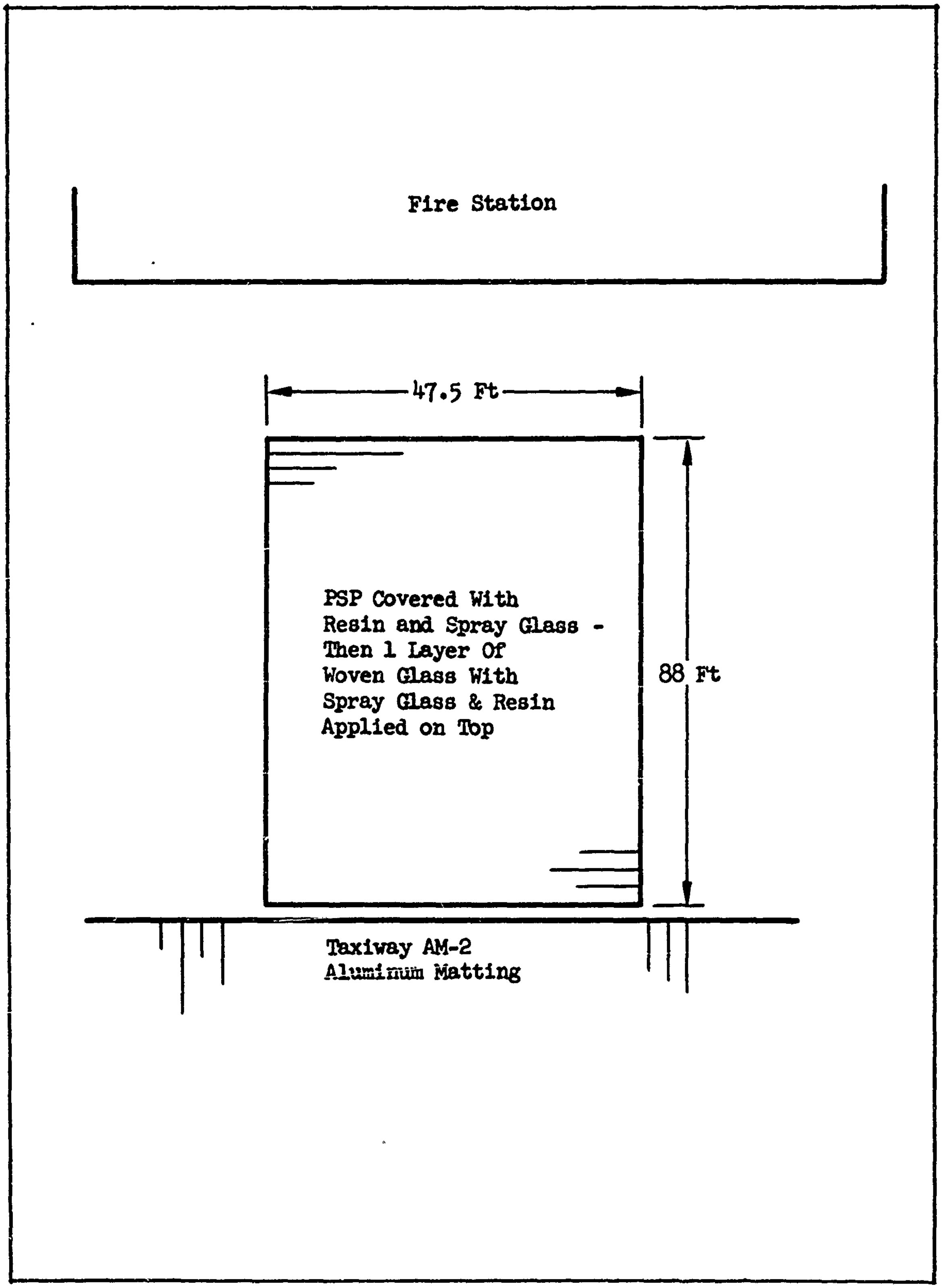


Figure 35. PSP Overspray At Fire Station

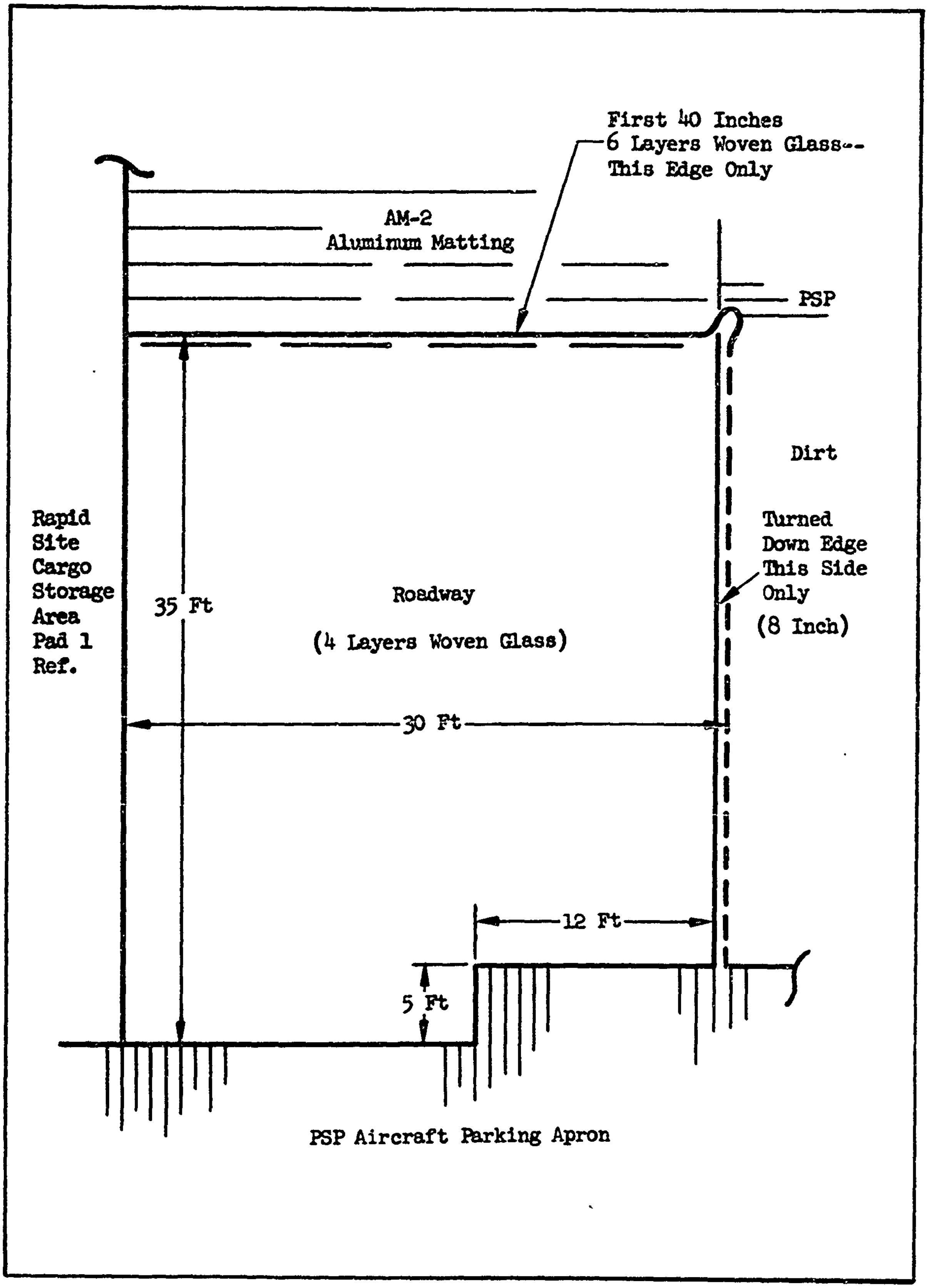


Figure 36. Roadway Site

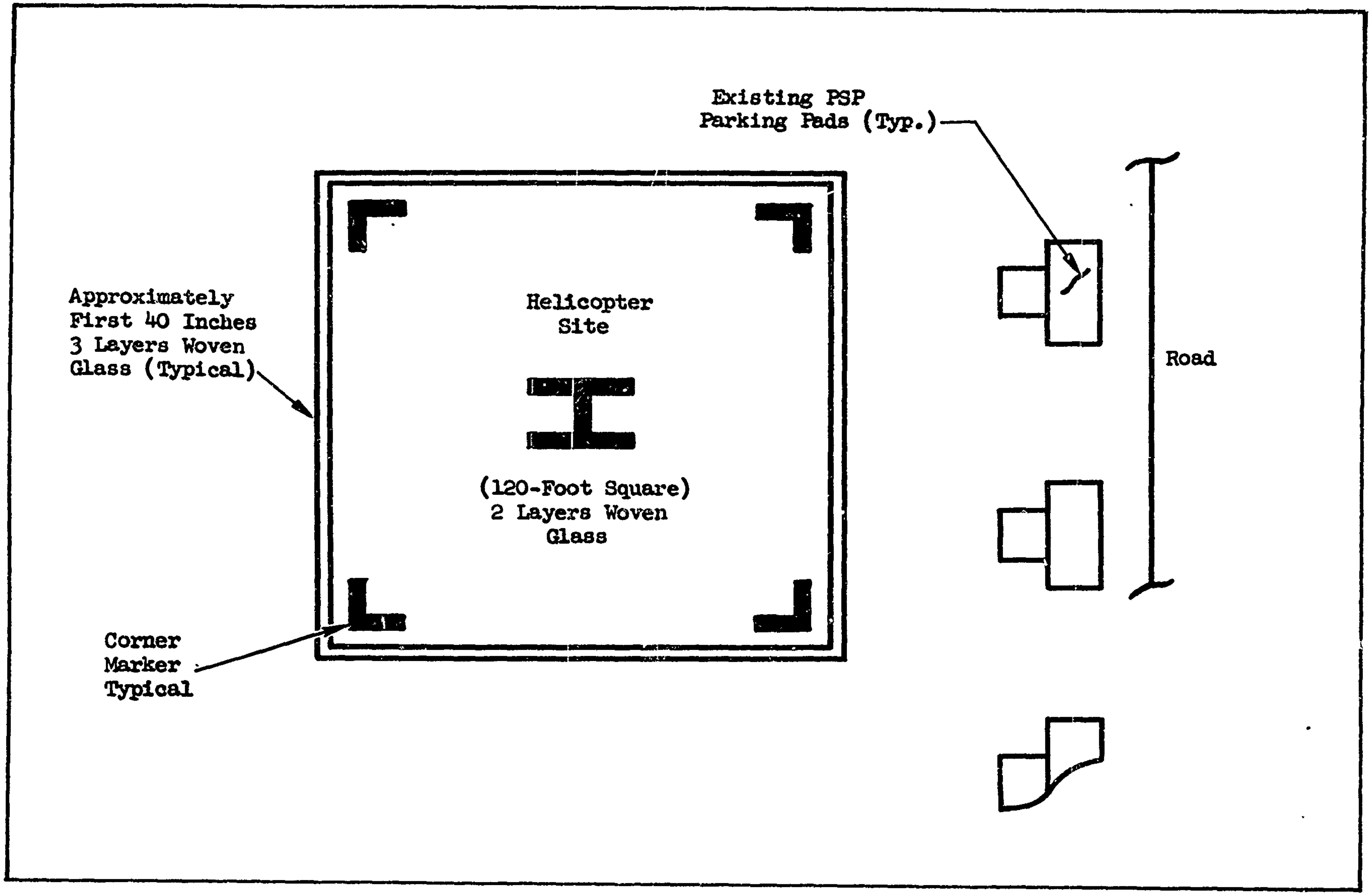
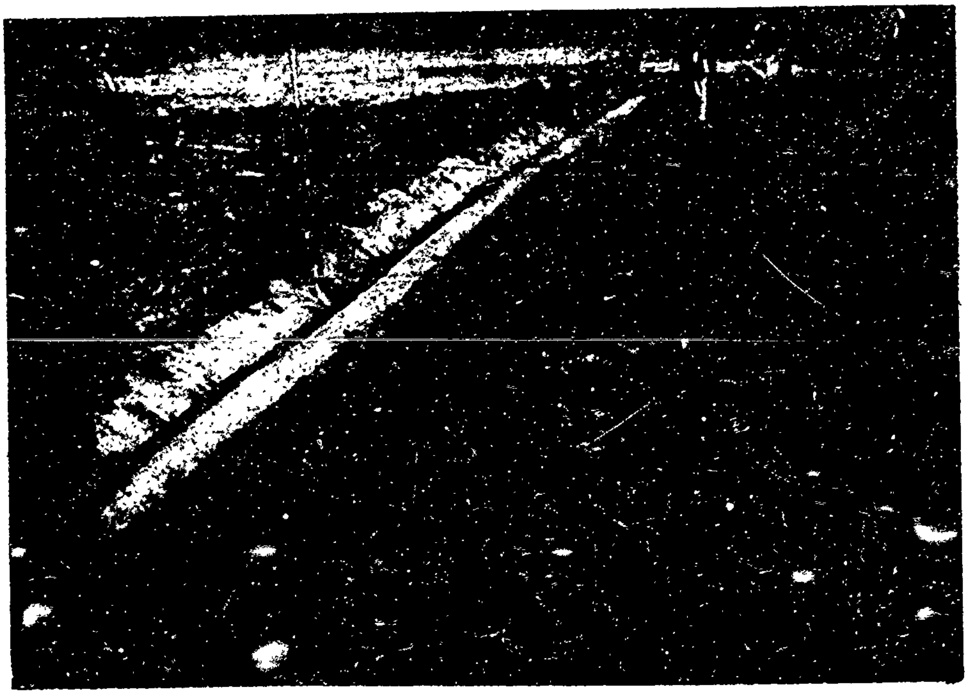


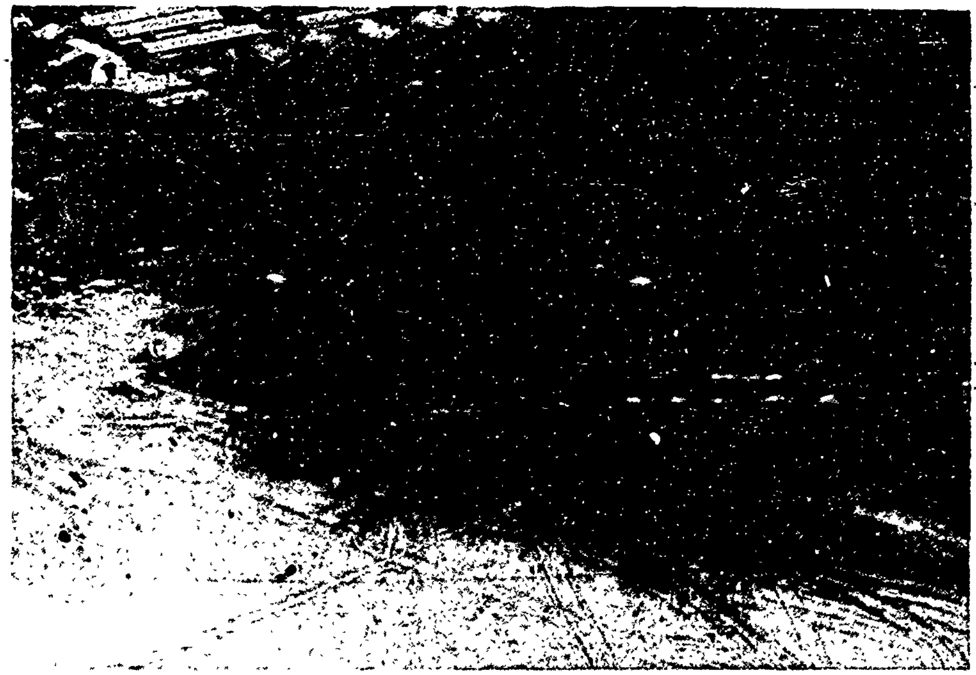
Figure 37. Helicopter Site



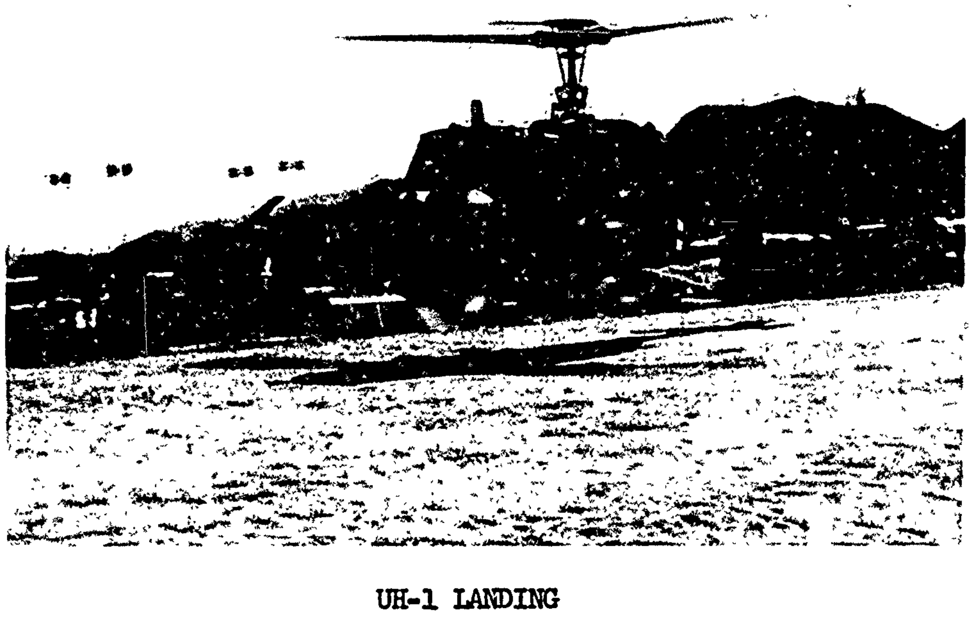
START OF CONSTRUCTION

CONSTRUCTION COMPLETION

Figure 38. Views of Helicopter Site Construction (Sheet 1)



COMPLETED SITE



UH-1 LANDING

Figure 38. Views of Helicopter Site Construction (Sheet 2)

TABLE XX HELICOPTER SITE AND HELICOPTER MAINTENANCE AREA SITE COVERAGE

Area	Materials Used (lbs) Resin (a)	Woven Glass (b)	Spray Glass (c)	Total Weight (lbs)	Area Covered (ft^2)	lbs/ft^2 Average	Percent Glass	Spraying Time (hrs)	Hours At Site
Helicopter Site (e)	29,740	5,170	1,710	36,620	14,400	2.54	18.75	5	20
Helicopter Maintenance Area (d)(f)	5,760	910	330	7,000	1,844	3.80	17.70	1.9	4.75
TOTALS	35,500	6,080	2,040	43,620	16,244			6.9	24.75

Notes:

(a) Resin weight figured at 10 lbs/gal

(b) Woven glass figured at 1.5 lbs/yd^2

(c) Spray glass figured at 30 lbs/roll

(d) Only one resin system used on this job

(e) Refer to Figure 37, page 87

(f) Refer to Figure 39, page 92

center of the site, and corner markers were painted at each corner as shown in Figure 37, page 87. The paint used was yellow traffic paint such as is used for painting taxiway center lines. Small glass beads were sprinkled on the markings while the paint was still wet to increase night visibility from the air. Several landings by UH-1 type helicopters did no damage to the heliport.

M. HELICOPTER MAINTENANCE AREA SITE

In addition, a helicopter maintenance area site was prepared adjacent to a PSP area, as shown in Figure 39, page 92. Figure 40, page 93, gives views of this site. Table XX, page 90, presents material coverage data for this site. This completed the SEA site construction program.

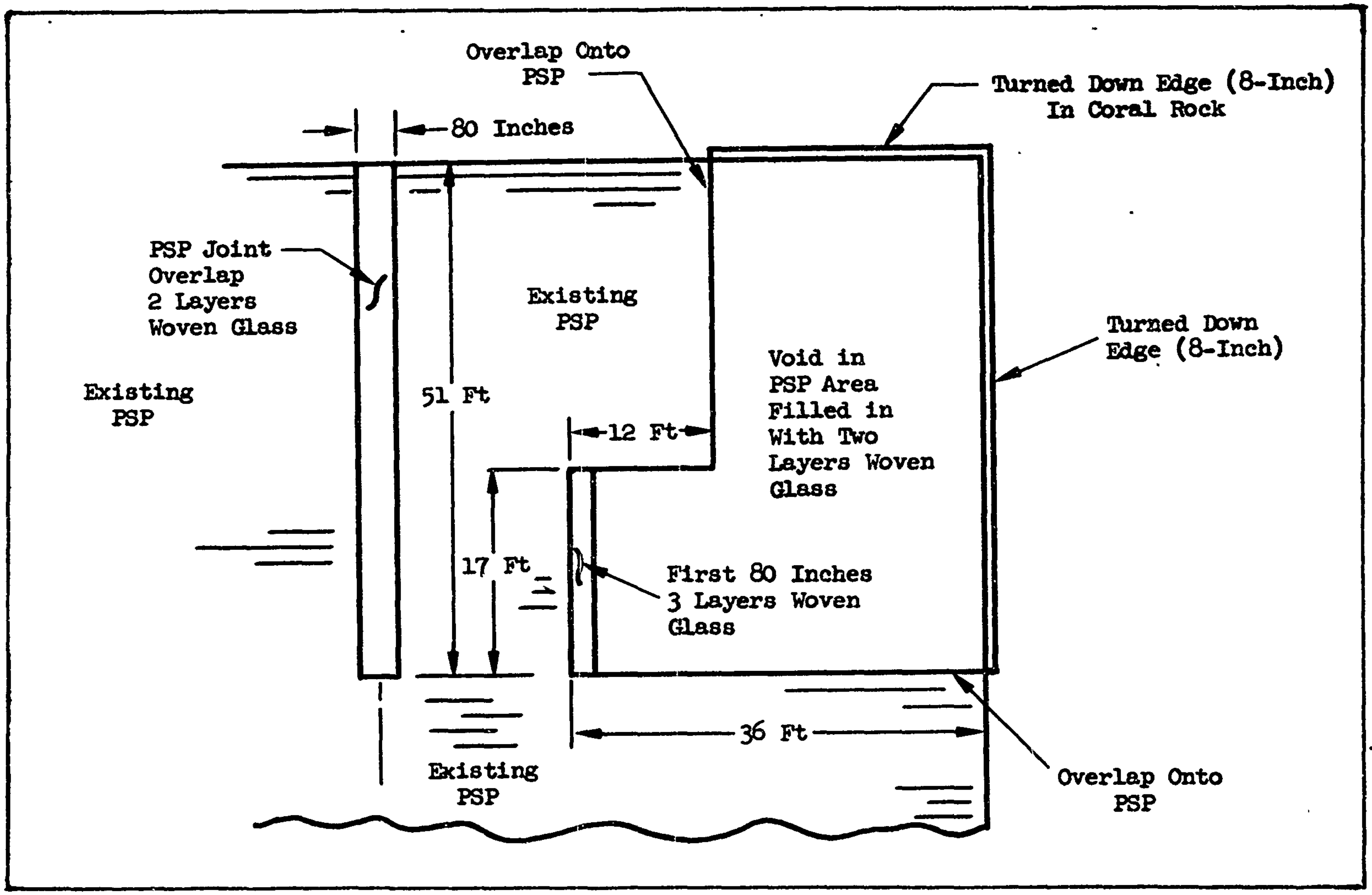
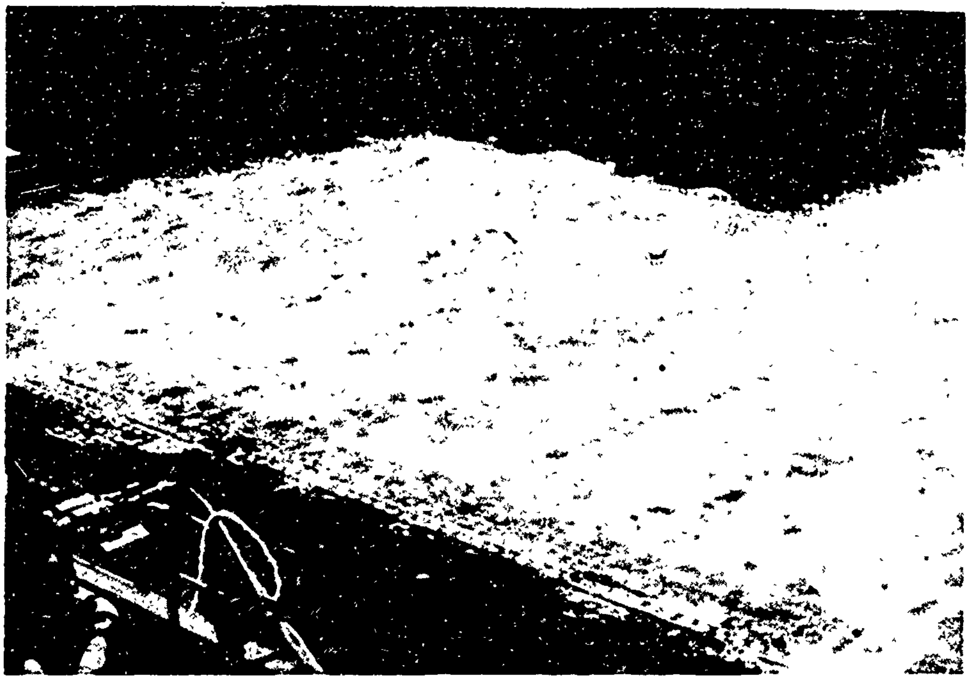
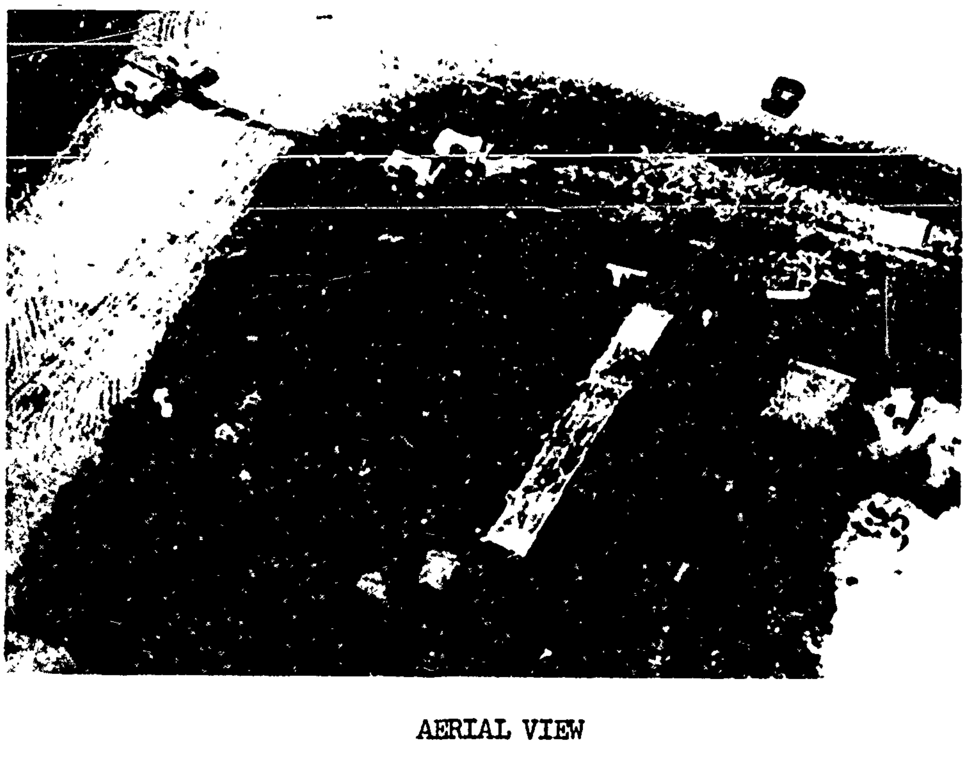


Figure 39. Helicopter Maintenance Area Coverage



GROUND VIEW



AERIAL VIEW

Figure 40. Views of Helicopter Maintenance Area Site

SECTION VIII

DISCUSSION OF EQUIPMENT AND MATERIALS

The Rapid Site Application Equipment performed well under the adverse environmental conditions (heat, humidity, sand, etc.) encountered in SEA. There were, however, fairly frequent hangups in the spray glass system, which were attributed primarily to the moisture and to the poor condition of many of the continuous roving glass spools. These glass spools were not in as good condition as usual, since the plastic bags that they were packed in were not sealed to make them moisture proof, and they were apparently damaged by rain and rough handling during shipping. There were fewer glass hangups when one glass spool was used, rather than two simultaneously.

Also, the woven roving glass fabric had not been rolled onto the cores well. There were numerous wrinkles rolled into the glass, which created additional work during site construction. The fabric was reverse rolled at the core end of the run, which also caused additional work.

During storage of the MEK peroxide in an air-conditioned atmosphere, many of the containers leaked, which created a messy handling problem. The MEK peroxide was packed in plastic bottles (eight pounds per bottle) four to the box. The four bottles were separated by a cardboard partition, placed in two cardboard boxes - all of which was covered with a plastic bag (sealed with a rubber band), and placed in a wooden box. The leakage came through all of these containers.

SECTION IX

CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

The versatility of the Rapid Site system was demonstrated during the Southeast Asia operation. This versatility included a stabilization covering to prevent soil erosion from natural winds or from jet engine exhaust turbulence, a weather resistant coating for sand bags, and load bearing surfaces for storage and/or trafficability areas. Throughout the program, the completed sites were inspected periodically to determine their condition after being utilized for their intended function. A final inspection at the completion of the program revealed that all the sites were in good condition and with no noticeable deterioration from either extremely hard usage or from weather conditions.

The materials utilized in SEA for the Rapid Site application system performed well except for the gun roving fiber glass. Considerable difficulty was experienced in spraying the glass due to moisture, not only from improper packaging for shipment, but from the high moisture content of the compressed air. In addition, the rough handling of the packing cases during shipment damaged some of the spools, combined with tight winding of the spools at the factory, caused improper runout of the strand and subsequent jamming of the glass hose and gun.

The Rapid Site application equipment performed reliably with no breakdowns under adverse conditions of high temperature and humidity and under an extremely dusty atmosphere. The maneuverability of the Dodge truck in deep sand was unsatisfactory; however, it performed as well as any other available wheeled vehicle.

The four resin trailers provided with the Rapid Site application equipment were considered to be sufficient for the job performed. Two trailers connected in series to the application equipment during spraying operation allowed mixing of the promoter into the resin and filling the remaining two trailers. An M-35 (2 1/2-ton truck) was used to tow the empty trailers back to the resin barrel storage area for refilling and allowed the Dodge truck to remain at the site to continue the spraying operation during the trailer refilling operation.

The operation in SEA provided training for ten Air Force personnel in the use of the equipment and in site preparation indicating that relatively inexperienced personnel can operate the Rapid Site system.

The Rapid Site system was far superior to any of the other soil stabilization materials observed such as Soil Guard, Coherex, or Cut Back Asphalt, because of its durability, strength, and weather resistance. Soil Guard will perform as an effective dust pallative in non-traffic areas on sand for a limited time period.

B. RECOMMENDATIONS

The various sites prepared in SEA should be inspected by Air Force Aero Propulsion Laboratory and LTV Contractor personnel after six to eight months of use to determine their condition and evaluate their effectiveness.

The experience with the gun roving fiber glass application system during the SEA operations indicates that for future applications, consideration should be given to substituting a glass system such as a mat for the glass spray system on flat or even surfaces. However, the flexibility of the glass spray system should be retained for areas where it is difficult to roll out woven roving or mats.

The principle of using rollers to assure good resin wetting of the fiber glass to obtain a high glass percentage in the Rapid Site system should be retained. However, for future applications, a larger and somewhat heavier roller would allow a faster and more satisfactory rolling operation than was experienced in SEA.

For future programs, better quality control of the fiber glass should be exercised to assure proper packaging in moisture proof containers and proper rolling of the woven roving on the cores.

Some difficulty was experienced with seepage of the $MEKO_2$ through the polyethelene containers. For future remote operations some consideration should be given to better packaging or to utilization of a different type of catalyst.

The application equipment experienced some difficulty in maneuvering through the soft sand encountered in SEA. The prime mover for future equipment should probably be equipped with a tracked system or utilize Terra-type tires with Super Terra-Grip tread such as found on the USAF Truck, flat bed, type MMI.

The Air Force team that was assigned to the Rapid Site team in SEA was well trained in the application system and in site fabrication techniques. In the event that additional materials are obtained for continued operations and that this team be dispersed due to rotation or other reasons, it is advisable that a contractor representative be assigned to assist in reactivating the Rapid Site system.

APPENDIX A

TABULATION OF APPLICATION EQUIPMENT AND SUPPLIES

SENT TO SOUTHEAST ASIA

Qty	Part No.	Description
4	78-00500	Tank Trailer Assembly
1		Barrel Handler
1	78-00533	Transfer Pump Trailer Assy
1	78-00532	Hoist Beam Assy
2	78-00541	Woven Roving Dispensing Cart
1	78-00505-2	65-B12 Prime Mover Assy
4	5618CSE-3	Air Conditioners
2		Lightweight Expandable Shelters
2	78-00455	Fiber Glass Pot
2	78-00555	Sleeve for Glass Pots
4	78-00608	Resin Hose Screen
1	5534	Hand Spot Light (Sears)
1		Barrel Spigot - Acetone
2		Lug Wrench and Handle (Dodge)
2		Barrel Cutters
1		Barrel Sling
1	61M	Drum Plug Wrench
1 ctn		Beads - Marking
1 ctn		Truck Copy, Operators Manual and Printed Material

APPENDIX A (Cont)

TABULATION OF APPLICATION EQUIPMENT AND SUPPLIES

SENT TO SOUTHEAST ASIA

Qty	Part No.	Description
2		Dusting Brush
1 pkg		Stencils
1 ctn		Paper Cups
4	MOD 7600	Eye Wash Fountains
5 lbs		General Purpose Grease
1		Line Marker - with Lid
1		Fire Extinguisher
6		Roller, Long Handle
4	NAG 100	Mixers - "Lightnin" w/Air Hoses
4		Mixer Shafts
1		Water Can, 5 Gal. (Gotkool)
2		5 Gal. Gasoline Cans
4		5 Gal. Acetone Cans
8 qts		#30 Engine Oil
8 qts		#50 PTO Oil
2		1 1/2" Pole Gun Tube Assy w/Ball Valve and 2 Swivel Joints
6		Pole Gun Heads
2		1" Pole Gun Assy
8		1" Pole Gun Tubes

APPENDIX A (Cont)

TABULATION OF APPLICATION EQUIPMENT AND SUPPLIES

SENT TO SOUTHEAST ASIA

Qty	Part No.	Description
2		1" Pole Gun Tube Extensions
3		Pole Gun Orifice Nuts
3		3/8" Orifices
1		1/4" Orifices
2		Glass Gun Heads
15		Glass Gun Tubes
36		1 Gallon Tin Cans w/Friction Lids
2 ctn	H 1992	500' Total 3/8" ID Catalyst Hose
25 ft		1 3/4" ID Flex Exhaust Hose
2		"Glass Craft" Pole Guns
2		70' - 1" Resin Hose Assy. (W) Catalyst Hose
1		Oil Suction Gun
13 pcs		360' Air Hose
2		20' -1" ID Solvent Clean Up Hose
4		Barrel Spigot 2"
9		12" Shears
1	#1040	Tire Pressure Gage
2	8785 AW	Blow Gun - (Schrader)
2		Air Chuck

APPENDIX A (Cont)

TABULATION OF APPLICATION EQUIPMENT AND SUPPLIES SENT TO SOUTHEAST ASIA

Qty	Part No.	Description
7		Head Sets Intercom
14		Head Set Extensions - 710 Ft Total
1		P. A. Speaker & Mike
1		First Aid Kit
1		Two Wheel Hand Truck
5 bgs		200 Pounds of Ca_2CO_3 Calcium Carbonate
1 ctn.		Catalyst O-Ring Grease
1		Ctn of 1 Pt Round Cans w/Friction Lids
1		Oil Can
2	CH 236APL	Fram Oil Filter Replacement Cartridge
2	1056-SE	Grease Gun w/6652-A Hose and 6304 Coupling
2	C001	Band-It Tool with J-001 Adapter
3 qts		Marvel Mystery Oil
2		Oil Squirt Cans
1 ctn		Parker Seal Lube
1		Portable Solvent Pump
1		14" Wrecking Bar
2		Monkey Wrench 11"
2		Pipe Wrench 24"

APPENDIX A (Cont)

TABULATION OF APPLICATION EQUIPMENT AND SUPPLIES

SENT TO SOUTHEAST ASIA

Qty	Part No.	Description
2	78-00550-2	Wrench, Special, Resin Hose (3 7/16")
2	78-00550-1	Wrench, Special, Resin Hose (3 9/32")
2		Wrench, Crescent 12"
2		Wrench, Crescent 8"
2		Wrench, Pipe 12"
1		Hammer, Claw 18 Oz.
1		Plier, Channel Lock
1		Operators Chair and Mount
8		3/8-Inch Slip Hook
1	MOD 1110	Tamco - Porta Pump w/Hose and Barrel Attach.
20	H-1446-3/8NPS	Coupling

APPENDIX B

TABULATION OF SPARE PARTS SENT TO SOUTHEAST ASIA

Qty	Part No.	Description
2	488-12DTE	Valve-Check Air-Catalyst (Republic)
1	488-8DI-2	Valve-Check (Republic)
1	11-002-085	Air Regulator (Norgren)
3	11-002-15	Air Regulator (Norgren)
1	18-013-003	Pressure Gage, Catalyst Pot
1	18-013-004	Pressure Gage, Solvent Pot
2	710-6-1/4 B	Valve-Control - Resin and Air Clutch
1	6168-X3	Unloader Valve - Compressor
1		Relief Valve - Air Receiver
2	313-13	Republic Valve
1	P10M057T	Dragon Needle Valve
1	213-12DT	Valve Republic
1		Pressure Gage Isolated (DeVilbiss)
1	12-002-036	Auto Drain Filter (Norgren)
12	No. 3	Link Locks and Strike Plates
6	H502-AL-R-AL	Ball Valve - 1"
3		Lever Handle - 1 1/2" Ball Valve
1	#1615	1 3/8" Bushing
2	QM-1458	Gasket, Catalyst Pot
4	MOD NPXK948	Varea Meter W/302 SS Body, 316 SS Stem, 316 SS Valve Seat, Viton O-Rings (Wallace & Tiernan)

APPENDIX B (Cont)

TABULATION OF SPARE PARTS SENT TO SOUTHEAST ASIA

Qty	Part No.	Description
6	NPXB	Float Ball - Catalyst Flow Meter
2	NPXK 948	Flow Meter Tubes
1	630 H300	Belt (2104 Cent. Dist) (Morse)
1	420-12	Hi-Lo Vari Drive Belt
1	A65-11	V-Belt Gates
1	A46	V-Belt
2	140XL037	Timing Belt (Woods)
1	A-65-11	Belt-Stl Cable
1	A46	Belt-Stl Cable
2	140XL037	Belt
4	220XL037	Belt
1	700XH300	Belt
5	B112	V-Belt, Compressor (T. B. Woods)
4	C-90	V-Belt (PTO) (T. B. Woods)
1	311-221-3/8 D	Valve - Air Catalyst (Republic)
11	PHC 4638	Hose Coupling - DeVilbiss
1	AD-12	Pipe-DeVilbiss Nipple 1/2"
4	AD-11	Nipple - 3/8" Pipe - DeVilbiss
3	H 2088	Nipple - 1/4" Pipe - DeVilbiss
90	HC 1028	Ferrules, Catalyst Hose
18	268-P	Male Connector (Poly-Flo) Eastman

APPENDIX B (Cont)

TABULATION OF SPARE PARTS SENT TO SOUTHEAST ASIA

Qty	Part No.	Description
30	260-P	1/2" OD Sleeve, (Poly-Flo) Eastman
2		3/8" ID Reinforced Glass Hose
1		3" ID Resin Suction Hose
300 ft		Poly Flow Hose
4	Series 3000	Quick Disconnect (Hansen)
1 bx		Viking Pump Gaskets
1	K124	Pump-Stl Fitted, Teflon Packed (Viking)
2	HL 124S	Pump - Viking
3 bx		Viking Shaft Seals
1 bx	EC-1126	Sealing Compound
2 bx		Miscellaneous Rubber O-Rings and Hyd Fittings
8	78-00509-8	1 1/4" x 3" Beaded Tubing
8	78-00509-9	1 1/2" x 3" Beaded Tubing
8	78-00509-10	2" x 3" Beaded Tubing
7		Catalyst Fidorkle Tubes
3		2 1/2" ID x 12' LG Hose Assy.
1		2 1/2" ID x 12' LG Hose Assy. w/Suction Probe
1		2" ID x 20' LG Hose Assy.
2		1 1/2" ID x 6' LG Hose Assy.

APPENDIX B (Cont)

TABULATION OF SPARE PARTS SENT TO SOUTHEAST ASIA

Qty	Part No.	Description
3		Cam, Trailer Brake, Parking
1 bx		Miscellaneous Band-It Clamps
1	MOD 40-B	Power Take-Off (Spicer)
1	MOD 40-B	Case PTO
1	MOD 111	Flow Meter - Neptune Type S
2	MC HL-3020 & 1590	Transmission Assy, Hi-Lo (MCHL-3020 Driver and 1590 Pulley)
2	420-14	Belt Hi-Lo
168 ft		1" ID Hose (Resin)
2		1 1/2" ID x 40' LG Hose
2		1 1/2" ID x 40' LG Hose Assy.
1		5/8" ID x 140' LG Hose
2		2" ID x 25' LG Hose Assy.
2		3/8" ID x 65' LG Hose Assy.
3		3/8" Poly Flo Hose Assy.
4 sts	2-250-013-838	Packing Sets for HL 1245 Pump
2 sts		Grease Fittings for HL 1245 Pump
2 sts		Packings for K-124 Pump
1	ACA-2	Tachometer Generator
1	MOD 450	Tach Indicator - Div No. 50; 0-5,000 RPM
14	262-P	Union - Poly Flo 1/2" OD Tubing

APPENDIX B (Cont)

TABULATION OF SPARE PARTS SENT TO SOUTHEAST ASIA

Qty	Part No.	Description
2	488-12DT-2	Valve Check Air/Catalyst
4	NPXN 94	Flow Meter Tubes with Balls
50	CPXA-25900	Viton "O" Ring
32	CPXA-24161	Viton "O" Ring
18	CPXA-26482	Viton "O" Ring
1		Flex Shaft - Vari Drive
2		Knob - RPM Adjust - Pump (Rogan)
1	2281-2 1/2" stem	Thermometer (Weston)
2	62 R	Fitting, Throttle Cable End
200 ft		Wire Rope 6 x 19 - 1/4" Dia.
100	H-92-G	Clip - Wire Rope
100	H-18-G	Thimbles
24	H-102-G	Screw-Pin Anchor
2	P-99	Plug (Dietz)
2	2006-6	Curly Cord (Dietz)
2	181-2W	Tail Stop Light (Black) (Dietz)
1	TC-50	Air Clutch (Tol-O-Matic)
6	2-463	"O" Rings
2	AN 816-16-12D	Unions
2		Seals for Catalyst Pot (Binks)

APPENDIX B (Cont)

TABULATION OF SPARE PARTS SENT TO SOUTHEAST ASIA

Qty	Part No.	Description
1		Throttle Cable Assy
2	NP-22	Pillow Block - (Sealmaster)
3	GP-8	Pillow Block
2	GP-16	Pillow Block
8	S516M	Sealmaster Pillow Blocks

APPENDIX C

TABULATION OF EQUIPMENT REQUIRED FOR SPECIAL TASKS SENT TO SOUTHEAST ASIA

Qty.	Description
1	Model 250-12 Semco Sealant Gun
1	#220 Hose Assembly, 5 Foot
1	#56 Service Tool
12	500-59 Washer
8	500-85-5 "O" Ring
4	500-58-1 "O" Ring
1	500-551 Swivel
4	500-57 Core
50	250-CP12 Cartridge
10	1010 Nozzle
10	8643 Nozzle
2	Sealant Gun Instructions and Parts List
6	Procedure Instructions
1	Breather Filter
2	Breather Face Masks
2	Wilson Face Shield
6	Respirators, Extra Filters, and Spare Parts

Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) LTV Aerospace Corporation Vought Aeronautics Division Dallas, Texas	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b GROUP

3. REPORT TITLE

Rapid Preparation of Quick Cure Resin Test Sites In Southeast Asia.

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Summary Technical Report, 1 June 1966 through 9 October 1966

5. AUTHOR(S) (Last name, first name, initial)

Blakeley, Clarence J. and Gifford, Francis.

6. REPORT DATE	7a. TOTAL NO OF PAGES	7b. NO OF REFS
February, 1967	112	

8a. CONTRACT OR GRANT NO. USAF Contract F 3361567C1009 b. PROJECT NO. BPSN 7 (63 817401 62405214) c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) None 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) AFAPL-TR-66-148, Part I

10. AVAILABILITY/LIMITATION NOTICES

"This document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of the Air Force Aero Propulsion Laboratory (APF), Wright-Patterson AFB, Ohio".

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	Air Force Aero Propulsion Laboratory Research and Technology Division Air Force Systems Command Wright-Patterson Air Force Base, Ohio

13 ABSTRACT Various types of load bearing and weather-resistant surfaces were fabricated in Southeast Asia (SEA) utilizing a quick-curing fiberglass reinforced resin system (previously demonstrated successfully under contract AF 33(615)-3631 Rapid Shelter Flooring and Helicopter Landing Sites). These test sites were constructed to gain operational data in the use of this construction method when utilized in a remote environment under actual use conditions. Ten different types of sites were constructed as follows: sand ammo revetment stabilization, cargo storage, engine runup station, sand bag emplacement, pierced steel planking overspray, roadway, heliport, helicopter maintenance area, quonset hut joint sealing, and metal revetment joint sealing sites. In addition, a team of 10 Air Force personnel was trained to use the Rapid Site application equipment. Latex base soil stabilization material was also tested in SEA on sand, but was not considered fully satisfactory because it broke up under foot traffic and high wind velocities. Prior to departure for SEA a 10-man LTV team was selected and trained, and specialized techniques were developed and tested. Other tests that were conducted included material toxicity, resistance to certain fluids, and rheological properties testing. A suitcase field laboratory was fabricated with equipment for determining stability, viscosity, gel time, active oxygen, and other material properties. The Rapid Site equipment operated continually under adverse environmental conditions encountered there (heat, humidity, sand, etc.) with no major problems. Inspection of the sites just prior to leaving revealed that all sites were performing their intended functions well, and were generally in very good condition. It is concluded that the Rapid Site System provides a very good solution to many of the various problems in remote locations like SEA.

DD FORM 1 JAN 64 1473 D23558

Unclassified

Security Classification

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT

INSTRUCTIONS

1. ORIGINATING ACTIVITY: Enter the name and address of the contractor, subcontractor, grantee, Department of Defense activity or other organization *(corporate author)* issuing the report.

2a. REPORT SECURITY CLASSIFICATION: Enter the overall security classification of the report. Indicate whether "Restricted Data" is included. Marking is to be in accordance with appropriate security regulations.

2b. GROUP: Automatic downgrading is specified in DoD Directive 5200.10 and Armed Forces Industrial Manual. Enter the group number. Also, when applicable, show that optional markings have been used for Group 3 and Group 4 as authorized.

3. REPORT TITLE: Enter the complete report title in all capital letters. Titles in all cases should be unclassified. If a meaningful title cannot be selected without classification, show title classification in all capitals in parenthesis immediately following the title.

4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.

5. AUTHOR(S): Enter the name(s) of author(s) as shown on or in the report. Enter last name, first name, middle initial. If military, show rank and branch of service. The name of the principal author is an absolute minimum requirement.

6. REPORT DATE: Enter the date of the report as day, month, year; or month, year. If more than one date appears on the report, use date of publication.

7a. TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.

7b. NUMBER OF REFERENCES: Enter the total number of references cited in the report.

8a. CONTRACT OR GRANT NUMBER: If appropriate, enter the applicable number of the contract or grant under which the report was written.

8b, 8c, & 8d. PROJECT NUMBER: Enter the appropriate military department identification, such as project number, subproject number, system numbers, task number, etc.

9a. ORIGINATOR'S REPORT NUMBER(S): Enter the official report number by which the document will be identified and controlled by the originating activity. This number must be unique to this report.

9b. OTHER REPORT NUMBER(S): If the report has been assigned any other report numbers *(either by the originator or by the sponsor)*, also enter this number(s).

10. AVAILABILITY/LIMITATION NOTICES: Enter any limitations on further dissemination of the report, other than those imposed by security classification, using standard statements such as:

(1) "Qualified requesters may obtain copies of this report from DDC."

(2) "Foreign announcement and dissemination of this report by DDC is not authorized."

(3) "U. S. Government agencies may obtain copies of this report directly from DDC. Other qualified DDC users shall request through ________________."

(4) "U. S. military agencies may obtain copies of this report directly from DDC. Other qualified users shall request through ________________."

(5) "All distribution of this report is controlled. Qualified DDC users shall request through ________________."

If the report has been furnished to the Office of Technical Services, Department of Commerce, for sale to the public, indicate this fact and enter the price, if known.

11. SUPPLEMENTARY NOTES: Use for additional explanatory notes.

12. SPONSORING MILITARY ACTIVITY: Enter the name of the departmental project office or laboratory sponsoring *(paying for)* the research and development. Include address.

13. ABSTRACT: Enter an abstract giving a brief and factual summary of the document indicative of the report, even though it may also appear elsewhere in the body of the technical report. If additional space is required, a continuation sheet shall be attached.

It is highly desirable that the abstract of classified reports be unclassified. Each paragraph of the abstract shall end with an indication of the military security classification of the information in the paragraph, represented as *(TS), (S), (C), or (U)*.

There is no limitation on the length of the abstract. However, the suggested length is from 150 to 225 words.

14 KEY WORDS: Key words are technically meaningful terms or short phrases that characterize a report and may be used as index entries for cataloging the report. Key words must be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context. The assignment of links, roles, and weights is optional.

DD FORM 1 JAN 64 1473 (BACK)

Unclassified
Security Classification

END

DATE

FILMED

4-67